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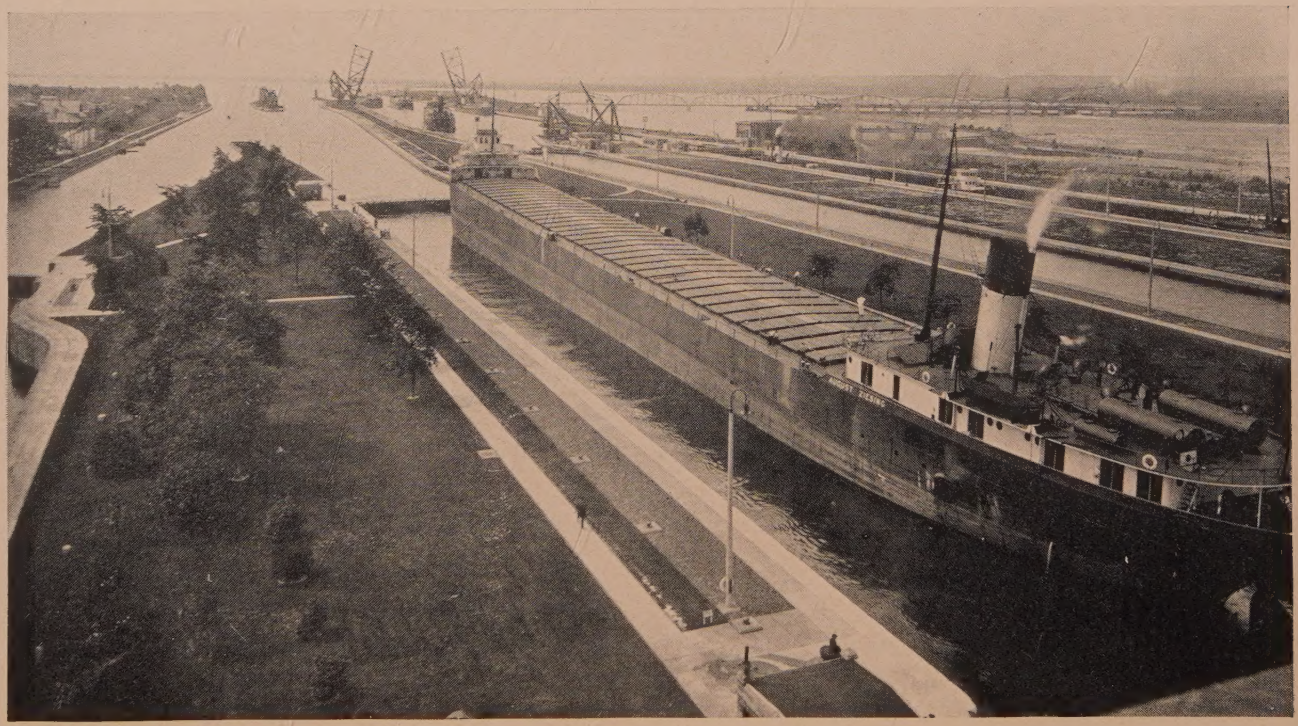

VIEW OF THE FOUR LOCKS ON THE MICHIGAN SIDE OF THE ST. MARY'S RIVER AT SAULT STE. MARIE, LOOKING UPSTREAM

From left to right the locks are Weitzell, Poe, Davis, and No. 4. A typical lake freighter is shown in the Poe lock. Two others in No. 4 lock bound down the lakes. In the distance the bridge to the Canadian side showing in midstream the works controlling the level of Lake Superior. Just over No. 4 lock, the power dam and power house.

SHIPWAYS TO THE SEA

OUR INLAND AND COASTAL WATERWAYS

BY
ERNEST S. CLOWES

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PREFACE

It has long seemed to me that in these crowded days something in the way of apology is due the public for any attempt to add to the store of supposedly authoritative books on any subject. A few years ago while attempting to find out something definite about the present state of our inland waterways I discovered that there was no one book in which the latest available information was collected, nor any which seemed to discuss it comprehensively and impartially. This appeared both as an opportunity and a challenge and this book is the result.

It is offered with a keen realization of its shortcomings in scope and treatment, and of the inevitable inaccuracies which in spite of the utmost care will survive all scrutiny of the text. For all of these I ask the charity of the more experienced, hoping that the book may stimulate the growing popular interest in waterways as a factor in national development and that it may direct that interest into channels of reason and common-sense.

Should it be found acceptable, the thanks of the reader as well as mine are due to the many who encouraged me to attempt it and who gave invaluable aid during its preparation. First among these are those of my family and friends for whom this sentence is written and who need not be named, who can know but little of how much I am indebted to them for their encouragement and confidence.

My thanks are due to many for aid in the collection of material and for a critical reading of the manuscript. From the inception of the task Mr. S. A. Thompson, secretary of the National Rivers and Harbors Congress, the assistant secretary Miss Mabel Goepfert, and other members of the staff gave me continuing direction to some of the best sources of information beside furnishing much themselves. I am also indebted to them for the cut showing the proposed control of the Mississippi and for many incidental helps and courtesies. The headquarters staff of the Corps of Engineers, United States Army, also gave fundamental assistance in the securing of official reports and similar material and especially in the selection of illustrations. Mr. Marcus W. Lewis, civilian assistant in the office of the Chief of Engineers, gave the whole manuscript a critical reading and made many essential corrections and suggestions. Mr.

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Charles P. Craig, executive director of the Great Lakes-St. Lawrence Tidewater Association, in addition to the use of the cut of the St. Lawrence, gave me access to the great mass of material that organization has collected, and his assistant and statistician, Mr. Charles J. McManus read critically the chapters on the proposed St. Lawrence and other waterways from the Great Lakes to the sea. The chapters on the Mississippi system and on floods were read by Prof. H. C. Frankenfield, chief of the Rivers and Floods Division of the United States Weather Bureau, who also furnished the latest data on the levels of the Great Lakes. The whole manuscript was read by Mr. Norman F. Titus, former chief of the Transportation Division, United States Department of Commerce; and by Dr. A. C. Flick, state historian of New York.

Special information on local conditions was furnished by many of the district offices of the Corps of Engineers. Data on lake levels and the diversion of water through the Chicago drainage and ship canal was also furnished by H. C. W. Laubenheimer, secretary of the Sanitary District of Chicago and by Ernest Bruncken of the Milwaukee Board of Harbor Commissioners. Mr. George W. Yates, Assistant Deputy Minister of Railways and Canals of Canada, gave me needed information on Canadian conditions, especially on the Welland Canal. In addition to reports on the New York Barge Canal, Mr. T. F. Farrell, Commissioner of Canals and Waterways of New York provided some excellent photographs. Photographs were also provided by the Duluth, Missabe and Northern Railroad. Coöperation from the Ohio Valley Improvement Association, the Cape Cod Canal Company, the Atlantic Deeper Waterways Association, the chambers of commerce of Stockton and Sacramento, California and of Portland, Oregon and other organizations and individuals too numerous to mention is also gratefully acknowledged.

Finally my thanks are due to the following publishers: Albert & Charles Boni, Inc., D. Appleton & Company, G. P. Putnam's Sons, and A. C. McClurg & Co., for their courteous permission to make use of copyrighted material.

ERNEST S. CLOWES.

Washington, March 5, 1929.

CONTENTS

CHAPTER I

The Picture and the Problem 1

CHAPTER II

Discovery 9

CHAPTER III

Growth, Decay, and Revival 18

CHAPTER IV

The Mississippi System 32

CHAPTER V

Floods 46

CHAPTER VI

The Great Lakes 58

CHAPTER VII

The St. Lawrence Waterway 73

CHAPTER VIII

Great Lakes Levels 89

CHAPTER IX

Other Routes to the Sea 105

CHAPTER X

Barge Canal Outlets from the Lakes 117

CHAPTER XI

Atlantic Coastal Waterways 132

CHAPTER XII

Dreams and Visions 144

CHAPTER XIII

West of the Rockies 153

CHAPTER XIV

Will It Pay? 161

CHAPTER XV

Looking Forward 170

CHAPTER XVI

Conclusion 181

Sources 185

References 187

Index 193

CHAPTER I

The Picture and the Problem

America is the child of the sea. Across that ancient road the pioneers of civilization made their daring way, seeking not a new continent but a short way to an old one. Stopped by this unforeseen obstacle, the early explorers cruised its shores from end to end seeking a way to enter into that unknown ocean whose waves washed the coasts of Zipangu and Cathay. To these adventurers of the sea the rivers and estuaries of the coast seemed the natural highroads toward their goal and for more than a century after Columbus they crept carefully yet boldly up these unknown waters in their vain search for a passage to the Pacific. So was the coast of America explored, and when the time came when men saw in the new continent not a mere obstacle but an opportunity for colonization, the first permanent settlers followed in the tracks of the explorers along the waterways of the continent, warily and with their backs to the sea at first but eventually striking boldly inland up these great rivers that beckoned toward the glamorous unknown.

From that soft tropic dawn when Columbus saw the green palms of Watling Island to the recent day when the first vessel steamed through the Panama Canal, the waterways of America, both natural and artificial, have been the ways of adventure, of colonization, and of commerce. Seeking a Northwest Passage, French explorers opened up all the region of the Great Lakes and descended the Mississippi upon which more than a century earlier De Soto had unknowingly stumbled. Also in quest of a passage through the continent, Henry Hudson discovered his beautiful river, the seaward end of what was soon to become and always to remain the best trade route inland. Other explorers ascended all the rivers of the eastern coast, by-and-by colonists followed them, until by the middle of the eighteenth century the line of permanent settlement reached from Montreal southwestwards close to the headwaters of the rivers that flowed into the Atlantic.

France tried to hem in the rapidly growing English colonies with a cordon of military posts placed along the waterways of the interior from Detroit to New Orleans. War followed; the French empire in America fell into the hands of Englishmen most of whom a few years later united

to win their independence and succeeded in setting up a new nation in this New World. It was a vigorous infant, this new nation. It grew with prodigious rapidity. The Appalachian Mountains were no obstacle. Crowding across them the pioneers looked down on a great forest stretching unknown miles westward but penetrated by mighty rivers down which their rude rafts might float them into their land of destiny. Along these flowing roads the colonists swarmed until, when the nation was less than a score of years old, Jefferson saw the future with a prophet's vision and added the whole vast territory of Louisiana to the national domain. A mighty river, the Missouri, flowed out of this unknown region and up it penetrated at Jefferson's orders the expedition of Lewis and Clark, crossing the future granary of the continent, crossing the Rocky Mountains, and finally floating out into the Pacific on that other great river up which some ten years before Captain Robert Gray of Boston had sailed his ship, *Columbia Rediviva*, and to which he had given part of his vessel's name. The era of discovery was complete.

Then came the Indian trader, the hunter, the trapper, the colonist. The steamboat vastly hastened the process until in the thirties of the last century the frontier had pushed well across the Mississippi and much of the length of the Missouri was being traversed by venturesome river steamers. But beyond this water highway there was none save those draining into the Pacific. Where the waterway stopped the trail of the "covered wagon" began, a trail that led only one way, a trail for pioneers, not for traders, adventurous but economically impossible. It was glorious but it was not business.

So the wave of settlement halted, but back of the frontier during these early decades of the nineteenth century before the coming of the railroad, civilization spread swiftly along the natural waterways and filtered out into the wilderness between through the spreading network of canals. The Erie Canal blazed the way. Completed as a shallow ditch of four feet depth in 1825 it led to a huge expansion of population, of agriculture, of industry throughout its whole extent from Buffalo to New York, for New York may be considered its real terminus. It became possible for the farmer in western New York to ship his wheat abroad at a profit. It presently became possible for the Illinois farmer to do the same by shipping his grain by the Lakes to Buffalo and thence to the sea by the canal.

The success of this enterprise led to the building of many hundreds of miles of canals. The Chesapeake and Ohio, from Washington to the

Ohio watershed, tried to compete with the Erie. The Erie itself was enlarged and extensions of it built north and south. Two canals across Ohio united Lake Erie and the Ohio River; another from Lake Michigan united the waters of that lake with those of the Mississippi. The coal fields of Pennsylvania were tapped by canals. Others were built or planned. Canada built the Welland around Niagara and began the Trent canal between Lake Huron and Lake Ontario. Civilization was to be floated into the wilderness on canal boats.

Then, in the late thirties and early forties of the century came the railroad, hesitatingly and experimentally at first, fighting its way in the face of canal opposition and of natural conservatism that believed there was something impious in being hurled across the face of the earth at the terrible speed of twenty miles an hour. But the railroad was bound to have the advantage in the end over such water transportation as then existed. Water will not run uphill but railroad trains can and do, and there in one sentence is one reason for the original decline in our inland waterways. The waterway was absolutely fixed. If a canal were built it could only be along relatively level lands. The Erie, and the Chesapeake and Ohio followed the only two practicable canal routes through the Appalachian Mountain system but by 1860 the mountains had been crossed by the steam engine at several other points. Before the coming of the railroad, cities and trade must needs keep close to the natural waterways or canals; the railroad made practicable the settlement of the whole country wherever land or mineral resources made settlement desirable.

But on through shipments the waterway still held its own. Not until after the Civil War did the Mississippi system surrender its supremacy to rail transportation, while the Erie held a commanding position a decade longer. Then the era of intensive railroad development came with the paralleling by rail of all the major water routes, the use of more powerful equipment, larger cars, swifter service. With all these natural advantages went a vast amount of murderous rate cutting, unfair discriminations against waterways on the part of their formidable competitors until, except on the Great Lakes and to some extent along the Ohio, inland water transportation was at the outbreak of the Great War an almost negligible feature of our transportation system.

It has recovered somewhat from the low point of that time; it is becoming increasingly important; but the question in many minds is whether it is worth while for the nation or the states to attempt to nurse

it into complete recovery. Is it a paying proposition now? Will it ever be? Why not abandon the rivers as traffic routes save for a few simple commodities; quit sinking money in canals, and depend on the railways to handle all the freight offered? Such is the problem. The answer may be given in two sentences.

If this country keeps on growing it is going to need more transportation facilities than the railroads can furnish without the spending of many times as much money as would be needed to complete a practicable system of internal waterways. That is one answer. The other is the fundamental physical proposition that it requires less work, less energy, less fuel, less money to move freight by water than by land.

There in a paragraph is the case for inland waterways but it is not quite so simple as it appears and the last sentence needs some explaining. While it is undeniable that it costs less to move freight by water once it is floated, the cost of getting it afloat is often a determining factor. On the sea it amounts to little more than the loading of a ship, but on a river it involves eventually the cost of maintaining the navigability of the stream, perhaps the construction of expensive dams; while on a canal it includes the whole cost of construction. There is no magic about capital. It all comes from somebody's thought or labor; eventually it comes from all our several pocketbooks, and if a canal that would not otherwise pay is built by state or federal funds it merely means that we, as taxpayers, have decided to subsidize such a means of transport.

Whether such a course is justified is the problem before the American people to-day. Perhaps it would be better to say "how much is it justified?" Some expenditures, such as keeping open a deep channel to New York harbor, are unquestionably sound; others, such as those for shallow canals across mountain ranges would unquestionably be silly, but between these limits there is a vast amount of room for discussion.

There are in the United States 295 navigable streams with a total navigable length of a little more than 26,400 miles. Forty of these rivers have at low water a ten-foot depth over 2600 miles of their courses and seventy more with a length of 3200 miles have from six to ten feet of water during the greater part of the year. The Mississippi and its principal tributaries alone have about 2500 miles of six-foot, low water navigation. In addition to these natural waterways there were in 1912, some forty-five canals with a total length of 2189 miles.[1]

These water highways may be divided into three or four great divi-

[1] *Report of the National Waterways Commission*, 1912, p. 90.

sions. Probably first in importance would be the Great Lakes, next the Mississippi system with all its tributaries. Finally there would be the waterways parallel or tributary to the coasts, in which class would fall such important links in water commerce as the new New York Barge Canal and the proposed ship canal or canals joining the Great Lakes and the sea.

It will be seen at once that two of these great systems are, taken together and with the aid of the New York Barge Canal or the proposed St. Lawrence Canals, fitted to serve that vast and important region lying from west of the Alleghenies to the western tributaries of the Mississippi, and from the Canadian border to the Gulf, holding within its far-flung area the majority of the population of this country and by far the greater part of its agricultural land.

Here in the heart of the continent, is the heart of the problem. Inland coastal waterways are at best but an alternative to the open highway of the sea, safer and more convenient perhaps but no cheaper. The possible navigation of the shorter rivers that run into the Atlantic or the Pacific, if not linked up with the interior or coastal waterways, serves but a limited region subject to effective rail competition. But in the great interior waterway systems of the Lakes, the Ohio, the Mississippi, the Missouri, the nation possesses a resource of hardly calculable value, a remedy for one of the most critical economic problems that it has ever tried to solve. The combined areas of the Mississippi basin and that of the Great Lakes basin lying within our boundaries amounts to more than two-thirds of our national area. Within the limits of that great extent of country dwells more than half of our population. The land and the people produce more than two-thirds of our agricultural products, more than half of our manufactured goods, more than two-thirds of our total exportable products.[2] And the richest and most populous and most fertile part of it is more than 500 miles from the sea, much of the best of it being 700 miles or more distant from tidewater.

The sea is not only the universal solvent of all material substances, it is the economic solvent of our world. It reduces all things to their real value, to a sort of least common denominator upon which nations build their economic policies. We may erect tariff barriers or provide subsidies of one sort or another but the true value of any exportable product will continue to be what it is worth free on board a vessel on the open sea whence it may be carried by the cheapest transportation known to the

[2] *Report on Nine-Foot Channel, Chicago to Gulf.*

great markets of the world. For this reason nations fight wars to win a free road to this universal highway of mankind. No nation cut off from it has ever maintained a commanding position in the world's trade or in political power. A roll-call of the great nations from ancient Egypt to modern Japan is a roll-call of maritime powers. A region cut off from sea transport by geographical or political obstacles is deprived of free trade in its widest sense; it cannot buy or sell in the best market, for transport charges to or from the sea eat up the profits. It is condemned to be the economic vassal of the nearest maritime nation or of the maritime regions of its own country.

Such, without water transport to the sea, is the apparent fate in store for our great central west. As an agricultural region it can not effectively compete in world markets with the products of South America, of Australia, of Africa, produced within easy access to salt water. It can not even compete with the agriculture of our own Pacific coast. Deprived of its preëminence in agriculture it is turning to industrialism to provide its farmers with a home market. But to do this its city craftsmen and mechanics must have a foreign market for their surplus and a foreign market means a sea market. Only because of our unrivalled supply of raw minerals and the use we have made of interior lines of water transport such as the Great Lakes have we been able to compete successfully in the world markets for manufactured goods against this handicap of expensive transportation from factory to sea. Relatively expensive would be a better term for our railroads give the cheapest rail transportation in the world, but within our own borders this is noneffective and with the completion of the Panama Canal we have seen the economic welding of the Atlantic and Pacific coasts at the expense of the interior. Freight can be moved so much cheaper by sea from California to New England than by rail from Chicago to the sea that factories in the interior are finding it increasingly difficult to compete on either seaboard with factories on either. The two coasts have become one economic unit. The interior is becoming isolated. But a remedy remains.

Nature has provided the foundation for it. It is for man to complete. Nature has provided two great natural waterways far into the heart of the continent. Neither in its natural state permits of access to the sea by the most modern forms of water transportation but in each case only a relatively small amount of work by man is needed to bridge the gap. To the north, the Great Lakes form even to-day the greatest inland water

highway on the earth, one might even fairly compare them to the open sea and say that hardly any section of the seas of all the world of equal extent surpasses the Lakes in the magnitude of its commerce if not in its variety. But this outlet of the west to the ocean is confined and narrowed by physical and economic obstacles that prevent it from yet being utilized to its full value. When, in a few years, the new Welland Canal is completed by Canada, less than fifty miles of shallow canals past the St. Lawrence rapids will stand as a barrier between the ocean commerce of the world and our lake ports. Let this barrier be broken down by a ship canal and these lake ports serving all the northern section of our great inland valleys will become so near the equivalent of seaports as to overcome probably nine-tenths of their present handicap in world commerce.

South of the Great Lakes basin, the system of rivers which finds its final outlet through the Mississippi spreads out a network of present and prospective waterways from Pittsburgh, St. Paul, Kansas City, and points even farther upstream, to the Gulf of Mexico. Coal is being carried downstream over these waterways cheaper than freight is being moved anywhere except on the sea and the Lakes. Grain and manufactured goods are being carried downstream and raw materials of many sorts are being brought from the sea to the factories of the interior by way of the Mississippi at a cost considerably under the rail charges. But this system is not yet complete. There are barriers in the Ohio, the upper Mississippi, and the Missouri that must be broken down before navigation can be carried on without interruption from low water at any season. There is another important and troublesome barrier between the Mississippi system and the Great Lakes, now partially broken through by the Illinois River and the Chicago Drainage and Ship Canal, whose clearing away would permit the union for barge traffic of the Mississippi and the Lakes. Finally, new types of boats and of terminal equipment must be devised so that the fullest use may be made of present facilities such as the New York State Barge Canal which already makes possible a continuous voyage for 2000-ton barges from Duluth to New York harbor.

There we have the picture and the problem. We see a continent opened to the world first by "those that go down to the sea in ships" and first explored by those who sought along its great inland water roads a way to a greater sea or in later days to a promised land of opportunity. We see the land colonised from the sea and the rivers. We see at last this great inland region becoming economically isolated through the

competition of lands more favored in their access to the oceans and now we behold it in the beginning of its struggles to free itself from these bands that constrain its future progress. That is the picture. The problem is how to do this most effectively, how best to use the ways that Nature has given us, how to link up the river systems, the Great Lakes and the coastal waterways in a practicable system of nation-wide extent and influence.

So, it will be the purpose of this book first to review the story of the discovery and the development of our inland waterways and to outline the story of their decline and revival where such revival has occurred. Attention will be given to each of the great systems and especially to the plans suggested for connecting the inland systems with the ocean. Finally, the practicability of a great inter-related system of waterways inland and coastal will be considered, a system working not in antagonism to but in harmony with rail and motor transportation and bringing the benefits of water transportation to the greater and most populous part of the nation. And while the emphasis of the book will be on the future and the present, it is realized that both have their roots in the past, a past moreover of romantic and practical interest. Let us then turn back the reel of Time some centuries and stand with the early explorers who, turning their faces from the Old World and with the light of the rising sun behind them steered their staunch and adventurous craft toward the unknown.

CHAPTER II

Discovery

The process of discovery resembles that of invention. Seldom is it the work of one man. Here or there one may see a little farther into the unknown region but it frequently happens that these early pioneers are somewhat bewildered by what they behold and can not bring home a clear and convincing tale of their adventure which, like themselves, sinks into obscurity. But by and by a man of clearer vision pieces together the stories of the pioneers, makes a few voyages into the unknown, has imagination, uses it; and presently the world is indebted to him for a new continent, a new philosophy, or a new application of energy. To call him the sole discoverer or inventor seems unfair to those early explorers whose names men forget. Unfair or not, it is the way of the world. The one who is the first to tell a clear story of his adventures gets the credit in the end.

So it has been in the gradual discovery of America. Leif Ericson preceded Columbus by nearly five hundred years but he not only did not comprehend the importance of his discovery but hid it in a neglected corner of the world so that for those five hundred years it was in the minds of even the best informed men hardly more than a rumor. Columbus gave his story the widest and best publicity available and because of that he is truly accounted the discoverer of America. Not long after him came hordes of adventurers who explored this mysterious New World. Some went according to a definite purpose, others aimlessly. Some of these stumbled on great discoveries but, ignorant or careless, they failed to understand them or to tell of them in such a way as to be of definite value in helping men to form a more definite idea of what they had found. Others saw more clearly and told more accurately what they had seen. They are the true discoverers.

By just this process came the discovery of the great waterways of the continent. One man stumbled on them, another explored them, finally someone told about them as much as was known and tried to interpret their significance. It took, for example, more than one hundred fifty years to truly discover the Mississippi. For the beginnings we must go back to 1528. In that year one De Narvaez, evidently a person with

enough influence in official Spanish circles to be entitled to share in that ancient source of graft, public land, was given title by Charles V to a huge area lying somewhere between Mexico and Florida. With the intention of looking over this interesting acquisition and of breaking the news not too gently to the aboriginal possessors De Narvaez assembled an expedition of several hundred persons near what is now Tampa and set sail.

It was getting late in the season. There was insufficient preparation; quite probably there was grafting; the weather became stormy; the expedition met disaster. There was among the survivors one Cabeza de Vaca who possessed enough courage and fortitude to hold a few together in a semblance of organization. These finally made their way after fearful hardships to Spanish settlements on the Mexican coast where along with their tale of disaster they reported that on November 1, they had discovered a point of low land jutting far out into the Gulf between which and a cape opposite they passed a broad river whose stream carried them far out of sight of land but whose volume was so great that they were able to get fresh water from the sea. This was probably the Mississippi.[1]

Thirteen years later, De Soto in a rather aimless ramble westward from Florida, saw and described the river from a point about thirty miles south of the present site of Memphis. He crossed the river there, building boats for his men and horses and describing the stream as about a mile and a half wide, very swift and deep, the muddy water carrying along many trees and broken timber. He was evidently impressed by his discovery but he thought of the river only as an obstacle, not as a highway.[2]

Then the Father of Rivers resumed his sleep of obscurity for a century and more until French traders and missionaries along the coast of Lake Superior began to hear stories from the Indians of a mighty river flowing southwards into a far distant sea. These stories came to the ears of two French missionaries at Fort Mackinac, Fathers Joliet and Marquette. Having themselves witnessed the development of the St. Lawrence and the Great Lakes as a highway into the heart of the continent, they saw in this river another road deeper into the unknown, perhaps leading into that "Vermillion Sea" northward and westward of Mexico.

They left Mackinac, May 17, 1673, ascended the Fox River from

[1] *Spanish Explorers in Southern United States*, p. 41.
[2] *Spanish Explorers in Southern United States.*

Green Bay, made the short portage from its headwaters to those of the Wisconsin and on June 17 floated out onto the upper Mississippi at Prairie du Chien. For a month they floated down stream, past the mouth of the Missouri and later of the Ohio until they were not far from where De Soto had been the first white man to cross the river. Here they heard enough to convince them that it emptied not into the "Vermillion Sea" but into the Gulf of Mexico, not more than ten days distant, the friendly Indians told them. White men lived there these Indians said, white men with guns and horses, and not wishing to get into trouble with the Spaniards, Marquette and Joliet turned their canoes up-stream to the Illinois River which they ascended to the Des Plaines, from which latter they made a short portage to the Chicago River and thence into Lake Michigan. They returned to Mackinac in September having made the first voyage by white men on the upper river and having correctly perceived the importance of the stream and of its tributaries in furnishing a network of waterways throughout this vast inland region.

Marquette not only furnished the information that enabled La Salle nine years later to descend the river to its mouth and to conceive the idea of a French colonial empire extending from the mouth of the St. Lawrence to the Gulf of Mexico, but he was the first to discover the Missouri and to see in it a way to the western sea that Lewis and Clark found practicable one hundred thirty years later. Writing of this river he related descriptions of it furnished by the Indians and stated,

"I have learned from them that by ascending the river for five or six days one reaches a fine prairie twenty or thirty leagues long. This must be crossed in a northwesterly direction and it terminates in another small river on which one may embark. This second river flows toward the southwest for ten or fifteen leagues and enters a lake, after which it flows toward the west where it falls into the sea. I have hardly any doubt that it is the Vermillion Sea and I do not despair of discovering it if God gives me the health and grace to do so."[3]

This adventure was reserved for Lewis and Clark. Marquette's information was rather sketchy and the "second river" probably referred to the Colorado rather than to the Columbia but the idea was sound, to ascend the Missouri to its source, cross the continental divide and follow a great river into the Pacific. This exploration was beyond the minds or the resources of the French of Marquette's day. La Salle had a difficult enough time in raising funds for his Mississippi voyage and in showing the

[3] *Jesuit Relations.*

French government the possibility of hemming in the growing English colonies along the coast with a cordon of military and trading posts along the Lakes and the inland rivers. La Salle gave his life for his idea, perishing in a mutiny of his new colony founded a few years later near the mouth of the Mississippi.

In its simplest form it was no new idea. France was already established from the Gulf of St. Lawrence to Mackinac and although the hostility of the Six Nations of the Iroquois Confederacy had barred her colonists from the southern shore of Lake Ontario and from Lake Erie their trading canoes had a relatively safe and much shorter way to the upper lakes by the Ottawa River, Lake Nipissing, and the French River. Hardly more than a generation after Columbus, Jacques Cartier in 1535 had sailed up the St. Lawrence to the site of Montreal. The rapids there told him there was no thoroughfare by that route to the great sea to the west, at least not for large vessels, but the hope that some way might be found lingers in the name "Lachine" given these rapids. The lure of the wealth of China was even then and continued for many years to be probably the most powerful motive for exploration of the continent. But settlement slowly followed the explorers and with the turn of the century missionaries and traders were penetrating into the western wilderness.

If there was no gold there there was copper for in 1609 some Indians had come into the growing trading post of Quebec with an ingot of the red metal a foot long which they had said had been mined on the shore of a great lake far to the westward. Six years later the Recollet Friar LeCaron had stood on the shores of Lake Huron and in the same year in company with Champlain had crossed Lake Ontario and entered the country of the Six Nations where Champlain fought a skirmish with Iroquois that resulted chiefly in confirming in them an implacable hostility toward the French. Sometime before 1629 Stephen Brule, one of the early members of the hardy company of "voyageurs" to whom France was indebted for many of her discoveries in the New World, penetrated past the falls of the St. Mary's River which he described, and traversed the whole length of Lake Superior, a journey of some nine days. He confirmed the reports of copper along its shores. But the missionary was not far behind the venturesome trader. Father Nicollet entered Lake Michigan in 1634, going as far as Green Bay and in 1641 Father Jogues, destined to martyrdom at the hands of the ferocious Iroquois, preached to the Indians at the outlet of Lake Superior.

By this time, only a few years after the first permanent English and Dutch settlements along the coast, all the Lakes except Erie were known to the French. It was getting to be believed that the great western sea was not far beyond Lake Superior. Two traders, Radisson and Groseillers, crossed to its farther end in 1659 and advancing into the wilderness beyond probably discovered the upper reaches of the Mississippi of whose greatness they and other white men were beginning to hear tidings. The fame of these early discoveries had been exciting and inciting imaginative and energetic men in Europe. One of these dreamers, a London merchant named Apsley, a contemporary of the great Elizabeth, had made a prophecy that failed to be fulfilled for more than two hundred fifty years when he said he expected to live to see a letter carried in three months from England to China by way of a route to be discovered across the American continent.[4] Other more practical men turned their minds toward exploration and colonization along the coast. And meanwhile in the wilderness beyond the Alleghanies the French power extended.

La Salle passed by the falls of Niagara in 1679 and along the shores of the Niagara River built the *Griffin*, the first ship to sail upon the upper lakes. Three years later he made his memorable voyage down the Mississippi, taking possession of the whole valley in the name of the King of France. Within fifty years the process of colonization seemed well begun. At Detroit and Mackinac, French posts commanded the upper lakes. Passage from the lakes to the valley of the Mississippi and its great tributary, the Ohio, was guarded by forts along the Wabash, the Maumee, the Fox and the Illinois Rivers. Cahokia, Vincennes, St. Louis were French outposts and colonies, and from the latter along the great river to the seaport of New Orleans a series of blockhouses maintained the hold of the greatest military power in Europe on the most extensive and fertile region of unoccupied land then known to be accessible to the white race. Tied together by bands of navigable water these outposts were France's hostages to world power; her new dominion was knit together by waterways and on this skeletal outline it was purposed to erect an empire that would strangle the English settlements now spreading inland from the coast.

For the English were awaking to their opportunity. Governor Burnet of New York, protected by the friendliness of the Iroquois to England and their hostility to the French, had established a trading post and fort

[4] Winsor, Volume IV.

at Oswego on the south shore of Lake Ontario. Tough and adventurous backwoodsmen from Virginia were crossing the western mountains and descending the valley of the Ohio, here and there making a little clearing or building a cabin. Some of these were taken prisoners by the French but others took their places. Virginia became alarmed at this obstacle to her expansion, decided to send a messenger to the French commander along the upper Ohio Valley, and on December 4, 1753, that messenger, one George Washington, adjutant of the Virginia militia, arrived at the French outposts on the Allegheny River and a few days later delivered his message from Governor Dinwiddie to Legardeur de St. Pierre the French commander at Fort LeBoeuf a little above Venango at the mouth of French Creek.

There was the usual exchange of diplomatic courtesy. Washington in the name of Dinwiddie demanded that the French leave the region which he said belonged rightfully to the British crown. St. Pierre in polite phrases replied that the Governor's message would be forwarded to Quebec for consideration; meanwhile he had no power to do other than obey his orders to hold the land. But, "in vino veritas," and Washington has recorded in his journal how after a dinner given by the French officers at the first outpost his hosts told him "that it was their absolute intention to take possession of the Ohio River and by God they would do it," laying their claim according to Washington upon the discovery made, "by one La Salle sixty years ago."[5]

So did fate ring up the curtain on the French and Indian War which ended with the English in possession of the entire Great Lakes and St. Lawrence watershed, the valley of the Ohio and its tributaries, and everything east of the Mississippi except Florida. Thenceforward it was the English who were pioneers in the work of discovery and exploration and if their rivals had left them little of first importance to discover they had the talent for colonization to a degree far surpassing the French. Even during the Revolution the work of settlement went forward, the news of the fight at Lexington furnishing a little band of Virginia pioneers beyond the mountains with the name of their new town. George Rogers Clark and his Virginians made certain the dominion of the united colonies from the Appalachians to the Mississippi and when the fighting was over the flood of new settlers burst over the mountain barrier and filled what then was called the "Northwest Territory" with men of

[5] Washington's Journal; also Parkman, *Conspiracy of Pontiac*, chapter IV.

English speech. Jefferson read the future and in spite of New England opposition bought from Napoleon the vast Louisiana territory, stretching westwards from the Mississippi to the unknown mountains of the West, beyond which the Pacific was known to lie. Down the tributaries of the Ohio, along Lake Erie, up and down the Mississippi the flat-boats of the pioneers made their way while far to the westward the muddy Missouri, flowing from out the unknown wilderness, beckoned to the fur trader and the explorer.

But the adventuring genius of the new nation had found another road of discovery, a water road, the road of the open sea. Down the length of the Atlantic, around Cape Horn, up the western shores of the two Americas the Yankee ships made their way to the Puget Sound region and the north Pacific coast. Spaniards had sailed thither two centuries earlier, French and English had followed them, but to the hardy sea traders of New England had come the vision of money to be made in furs. Trading the knick-knacks and rum of New England for valuable furs they sold these in turn to the mandarins of China for the tea and silks of Canton which they finally, at immense profit, sold in Boston or New York.

To all these early explorers and traders along the Pacific coast had come tales of a great river rising far inland. It was a river of mystery and of doubt. One navigator after another sought it in vain, for the iron coast of Oregon is a poor place to cruise in such hardly managed ships as these captains commanded and few cared to stay long near enough to an unknown coast to make a thorough search. The Englishman, Captain John Meares, nearly discovered the river but like many another discoverer failed to recognize his opportunity, when on July 5, 1788, he sighted a wide bay between two capes. Standing in toward shore he found the water rapidly shoaling and a heavy sea breaking on a bar which appeared to extend across the entire estuary from headland to headland. So he named the northern cape, "Disappointment" and sailed away.

Again the honors of discovery were dangled in front of England and again she disdained them when, late in April, 1792, Captain George Vancouver passed the mouth of the river. He was near enough inshore to see the breakers whitening the bar but he had known of Meares' earlier visit and apparently felt confidence enough in his observations to think it merely a waste of time to try to enter the bay. Two days later his ship fell in with the *Columbia Rediviva*, Captain Robert Gray, out of

Boston. After the manner of the sea, the two captains exchanged courtesies. Captain Gray had an interesting yarn to tell. He had, he said, found what was evidently the mouth of a great river, so great that although he had tried for nine days to enter its mouth the current kept him at sea. The description of this river mouth was that of the place Vancouver had just left and which Meares had visited four years before. Vancouver pooh-poohed Gray's observations, saying that what he had seen confirmed Meares' observations and that as both of them agreed there couldn't possibly be any river at the place indicated.

Gray apparently gave Vancouver full warning that he intended to make another try at this possible river but the latter was so sure of the infallibility of the British navy that he continued his voyage. Gray put his ship about and a few days later was off the mouth of the great stream which as yet no white man had ascended. Again winds were contrary and for a few more days he stood back and forth in sight of the headlands waiting a favorable wind and tide. Upon May 11, 1792, the long-awaited combination occurred and Gray ordered all sail set and the vessel's bow turned toward the entrance of the bay. The bar was safely crossed and by nightfall the *Columbia Rediviva* was twenty miles upstream. Anchoring for the night, Gray took his vessel fifteen miles farther up the river the following day. Then, with the water shoaling somewhat and the channel uncertain, he put downstream and to sea to give to the world the story of the discovery of the last great river of temperate America, named by him "Columbia," and through his discovery to make firm the claim of the infant nation along the far Atlantic coast to the fairest and richest watershed of the Pacific coast of the two Americas.[6]

It was perhaps the news of this discovery that was the determining factor in Jefferson's decision to buy Louisiana. For the purchase was hardly more than completed when he ordered Captain Merriwether Lewis and Lieutenant Clark of the United States Army to get together an expedition to undertake the most purposeful and thorough exploration ever made in America since La Salle set out from Montreal for the mouth of the Mississippi. Lewis and Clark were ordered to ascend the Missouri to its source, to cross the Rocky Mountains, and to descend the Columbia to the Pacific. They were to make observations of the mineral and agricultural possibilities of the region, to make a survey of their route,

[6] *The Columbia River*, Lyman.

and to study the Indians and to be at pains to concilliate them, and to return either by ship or overland as seemed best to them.

They started in the early summer of 1804, went into winter quarters among the Indians of the Dakota country and resumed their journey the following spring. On August 12, one of the expedition stepped across the little rivulet that marked one of the sources of the Missouri and thanked God he had lived to bestride that stream. Not long after, they began their long descent of the Snake and the Columbia and on November 7, 1805, they saw the billows of the Pacific breaking on the lonely coast.

Lewis and Clark and their companions were certainly the first white men and probably the first of all men to make a continuous overland journey from the Atlantic watershed to that of the Pacific, following the course of the three great rivers, Ohio, Missouri, and Columbia. With them the era of discovery of the waterways of habitable America practically ended. It had lasted just about two hundred seventy-five years, since Cartier sailed up the St. Lawrence. Spaniards had cruised the Atlantic coast and to a Spaniard went the honors of the first sight of the Mississippi, the greatest river of all. English and Dutch had discovered the Hudson, the Chesapeake Bay, the lesser coastal rivers; Frenchmen had been the first Europeans to see the Great Lakes, to navigate the Ohio and the Mississippi and to open up the vast system of inland rivers that are tributary to these greater waterways. Their dream of empire faded, the British vision of a vast colonial America was shattered, and it was reserved for a new nation to inherit the dreams and the more solid fruits of discovery of its predecessors and to develop and settle this new continent.

Without waterways it would have been an almost impossible task. Over the water the Old World had sailed to find the New. And now, three centuries after Columbus, a new nation was growing here, its very life-blood those whispering highways, beckoning westward and southwards through the dark forests, bearing the very elements of which a people and a nation are made, the arteries of our youthful, growing land.

CHAPTER III

Growth, Decay, and Revival

The coming of peace after the Revolution terminated a period of nearly thirty years of conflict along the frontier. It released for fruitful activities the energies of a people and it opened for the field of these energies the heart of a continent of unknown extent and wealth. Access to this unknown or little known region was almost wholly by waterway and so it happened that with the first rapid growth and expansion of the people of the United States came the first period of rapid expansion of inland water traffic.

Among all our rivers, inland or coastal, one alone at this time stands preëminent in importance, and that river is the Ohio, "La Belle Riviere" of the French, "The River of Many White Caps" of the Indians. Other rivers such as the Hudson or the Delaware might empty into the sea at or near the site of populous and growing cities but the Ohio was the only one leading directly from the frontier into the very heart of the continent and affording access not only to the whole course of the Mississippi but to those lesser known streams which water what are now the states on both sides of the Ohio and the upper Mississippi.

"Once across the Appalachian range there was but one river, and over the Ohio and its tributaries that race (the English) spread its marvellous conquest. . . . . The Ohio was the strategic course of empire to the heart of the continent and there is no phase of its history that is not of imperishable significance."[1]

The first craft on the Ohio used by white men were canoes fashioned after those of the Indians. These were cheap and easy to make and they served admirably for quick communication, for the explorer, and for the fur trader whose valuable wares needed little space. But for the conveyance of bulk freight such as the household goods of settlers or their primitive commerce, canoes were of little value, and the needs of the pioneers soon developed the flatboat and later the keelboat. The former were scarcely more than rafts but the latter were built on a crude frame, were decked over, and contained some sort of cabin or covered quarter.

[1] *The Ohio River*, Hulbert.

The typical keelboat was a craft about thirty feet long, twelve feet wide, drawing not more than two or three feet of water and capable of carrying a cargo of from fifteen to forty tons. Propulsion up-stream was possible by the use of poles which also were used to assist the force of the current in downstream journeys. Deckhands, one on each side of the vessel, thrust their poles to the bottom and walked along the deck from bow to stern. This was a hard and toilsome way of furnishing power but it sufficed and it even became possible to run keelboats with some sort of schedule. In fact the first line of packet boats on the Ohio or for that matter on any inland river in America was a keelboat line between Pittsburgh and Cincinnati established in November, 1793, by one Jacob Meyers who was, so he said, "influenced by a love of philanthropy and a desire of being serviceable to the public." Further evidence of his philanthropic desires is perhaps found in his announcement that "passengers will be supplied with provisions and liquors of the first quality."[2]

Hard liquor was in fact considered one of the necessities of life to the pioneer and because of its universal manufacture, the cheapness of its production from corn grown on virgin soil, and its combination of high value in small bulk, it soon became one of the leading articles of commerce along these frontier water highways. Grain, flour, pork and whiskey were the staples carried by these flatboats or keelboats from the rude clearings of the upper Ohio to the French settlements along the lower Mississippi. The profit from this trade, in which the crude staples were exchanged at New Orleans for money or for sugar and other products of civilization brought up-stream by incredible labors, encouraged a few enterprising men along the Ohio to a new venture, perhaps the most picturesque in all the history of our inland waterways.

We hear much to-day about bringing the inland valleys to the sea by ship canals or by a deeper Mississippi and optimists look forward to the day when not only Chicago and Duluth will be seaports but St. Louis and Cincinnati as well. But few people know that even if these visions come true they will be no new thing. Ships have been built on the Ohio that have borne cargoes to Havana and other West Indian ports and while there is no record of such a vessel ascending the stream from the sea, the period shortly before the war of 1812 saw a number of such craft carrying the products of the Ohio Valley to the seaports of the Gulf and Caribbean.

[2] *The Ohio River*, Hulbert.

The first of these ships of romance was the *St. Clair*, a brig of 110 tons, built at Marietta, Ohio, in 1800, her commander being the famous Commodore Abraham Whipple of Revolutionary fame, who in fact helped precipitate that conflict by leading the expedition which burned the British cruiser *Gaspe* in Narragansett Bay in 1772. The *St. Clair* sailed from Marietta in May, 1800, with a cargo of flour and pork for New Orleans which was safely reached in July. Here additional cargo was taken on and the ship from the wilderness sailed for Havana where her cargo was traded for sugar. The staunch little brig then set forth in August for Philadelphia where the following month ship and cargo were sold at a price that netted a handsome profit to the owners. This successful adventure led to others of like nature. Two more seagoing vessels were built on the upper Ohio in 1801, four in 1803, two in 1804 and eleven during the next four years. Louisiana was then United States territory but the troubled relations with England followed by Jefferson's embargo on foreign commerce put an end to these venturesome yet profitable enterprises. When the War of 1812 was ended, the era of the steamboat was dawning.[3]

Meanwhile through all the war years and in the face of hostile Indians, the country along the Ohio was filling up with white men from beyond the mountains, men who came with their wives and families by toilsome overland trails to the headwaters of the Allegheny or the Monongahela, felled trees to make rude flatboats or keelboats on which they drifted downstream to a likely looking location for settlement, or after a journey of days with the current, poled their clumsy craft up the Muskingum or the Wabash into Ohio or Indiana. These two states and Illinois were all admitted into the Union during the decade between 1810 and 1820. In this same period the population of Indiana increased 500 per cent[4] and that of the other valley states at a rate not far below that figure. Rough roads were being built through the forests but the main reliance of travelers was the river. Traffic on it had become so important that as we shall see later the beginning of a program of river improvement had been made and government vessels and engineers were busy removing snags and building rude dikes to direct the flow of the stream. For another decade the keelboat was to dominate the scene and it was on an even simpler flatboat the young Abraham Lincoln in the late twenties of the young century made his famous trip to New Orleans. But in

[3] *The Ohio River*, Hulbert.
[4] *The Ohio River*.

1807 Robert Fulton had piloted his steam-driven *Clermont* from New York to Albany before the eyes of a skeptical world; and the steamboat age, the Golden Age of our inland waterways, was at hand.

The story of that romantic epoch has been told many times and need only here be sketched in its broader outlines. It lasted about fifty years, from the round trip of the *Washington* from Louisville to New Orleans in forty-one days in 1817 to the famous race of the *Natchez* and the *Robert E. Lee* up-stream from New Orleans to St. Louis in 1870, the *Lee* winning by six hours in the time of three days, twenty-one hours and fifty-eight minutes for the course of 1278 miles.[5] During this interval, the river steamboat was the life of the Mississippi Valley. It fed body and soul. It carried out into the wider world the products of the settlers' toil, the produce of their land, the merchandise of their developing industry. It brought to them the sugar and coffee of the tropics, the ironware of Pittsburgh, the raw cotton of the south, the cotton cloth of New England. More even than that, the steamboat brought the spell of romance, the dim sense of national and world unity to the minds of dwellers within sound of its deep-throated exhaust or melodious whistle. Out of the unknown world around the distant river bend these graceful craft came with their commerce of far countries; around the farther bend they merged again into the mystery of the unknown world, migrants of commerce with all the inspiring sense of power and all the alluring call of adventure for the youth of the river valleys. They helped form the mental and spiritual background and mould the character of such different though typical Americans as Abraham Lincoln, Mark Twain, and John Hay; they built, united and helped keep united a great nation, and they developed a culture mirrored in a literature which will be forever among the treasures of the American tradition.

The first steamboat on the Ohio was the *New Orleans*, built at Pittsburgh in 1811. It was probably the largest craft that had ever been built along the river, 138 feet long, 300 tons. It left Pittsburgh in October at the conservative speed in still water of eight miles an hour and after some delay at the "falls of the Ohio" at Louisville, reached Natchez in December, never returning to its birthplace but going into the lower Mississippi trade. The huge profits of this vessel which cost $40,000 to build and made a net return of $20,000 the first year encour-

[5] Chambers, *The Mississippi River*, pages 229–230.

aged the building of others although for several years it was believed that no steamboat would be powerful enough to ascend the Ohio. The *Enterprise* in 1816 was the first to make a round trip from Louisville to New Orleans and as we have seen the *Washington* excelled this feat the following year. Its performance of forty-one days for the round trip was considered astonishing. Thirty-six years later the up-stream trip was made in 105 hours.

By 1819 there were sixty-three steamers on the Ohio and this had increased by 1832 to 230. Ten years later there were 450 steamers operating west of the mountains and during that year 1842 there were forty-five boats built at Cincinnati, thirty-five at Louisville or nearby and fifteen at other points along the river, the total tonnage on the river being 26,788. The relative importance of these figures may be measured by the fact that the total steam tonnage of New York City at the same date was only 35,260 and of the whole Atlantic seaboard not far from 100,000. In fact the steam tonnage of the Mississippi and Ohio systems in 1834 was greater than that of the whole British Empire by just about fifty per cent, the relative figures being 126,278 and 82,696.[6] Annual river steamboat arrivals at New Orleans exceeded 200 as early as 1821, passed the thousand mark in 1833 and reached their highest point in the year ending in August 1860 when steamboat arrivals from river points numbered 3245 or about nine a day. Tonnage carried exceeded 100,000 before 1820 and 500,000 by 1840.[7]

The development of steamboating on the upper Mississippi and on the Missouri paralleled the growth of the country and lagged but little below that on the lower river. The *Zebulon M. Pike* of thirty-seven tons was the first steamboat to ascend the Mississippi from the mouth of the Ohio, arriving at St. Louis in August, 1817. Two years later the *Independence* steamed 200 miles up the Missouri to Boonville and a little later the same year the *Western Engineer*, a little craft some seventy-five feet long, arrived at Council Bluffs, 650 miles up-stream from the mouth of the Big Muddy. On the upper Mississippi commerce developed more slowly but there were forty-eight arrivals at St. Paul in 1845. Thirteen years later they numbered 1090, a mark never since approached.[8]

But with the growth of steamboats as means of transportation there was developing in the east and spreading slowly westwards a far older

[6] *The Ohio River*, page 337.

[7] *Inland Water Transport, in the United States.*

[8] Chambers, *Mississippi River*, page 228; also *Old Times on the Upper Mississippi.*

and simpler method of water transport, destined also to make an imperishable name in the history of the growth of the United States and to inspire its people to the construction in these modern days of world-famous works of transportation engineering. Canals have been used since remote antiquity but never has there been any record of their having been such an influence in the building of a nation as in this country in the first half of the nineteenth century. Probably the first ever projected here was that across Cape Cod from Massachusetts Bay to Buzzards Bay. As early as 1623, Miles Standish had traded with the Dutch from New Amsterdam across this narrow isthmus and in 1697 the General Court of Massachusetts had ordered an inquiry on the practicability of a canal at that point. But the first real canal in America, the type and example and model of all succeeding ones was the Erie.

From early in the eighteenth century there had been an important trade route up the Hudson and the Mohawk Valleys, across a short, almost level portage to Oneida Lake and thence down the Oneida and Oswego Rivers to Oswego where in 1725 Governor Burnet built a fort. It was an English route paralleling that of the French up the St. Lawrence, and when the war with France came, Oswego was an objective important enough to the French for them to send the Marquis de Montcalm and several thousand men to capture. This was done but it was a barren victory, for the issue of the war settled the ownership of Oswego. After the Revolution the British held Fort Ontario there for several years as a security for the performance by the United States of some of the provisions of the treaty of peace but with its surrender this country had an uninterrupted route across the state of New York to Lake Ontario and thence to the upper Lakes.

About this time, the last decade of the eighteenth century, there came to the shores of Oneida Lake one George Frederick William Scriba, a Hollander who had arrived in New York a few years before with a great amount of ready money acquired no one knew just how, excellent letters of introduction, an optimistic temperament and evidently a compelling personality. He made himself very well and favorably known in New York City and succeeded at last in securing a grant of a huge area in northern New York extending from Oneida Lake to Lake Ontario. Moving into the wilderness, he founded what he expected to become a great city on the north shore of Oneida Lake. He saw a canal up the Mohawk Valley to the lake and another cutting across to Lake Ontario from his future metropolis which was to be a cross roads of traffic and a

commercial capital worthy to live up to the name he gave it, Rotterdam, after his native city. Scriba never saw his dream come true. His old home was still standing a few years ago but the city of his visions, its name changed to Constantia, endures only as a pleasant little village steeped in decades of rural peace and calm.

But Oneida Lake is only a dozen miles or so from the old village of Onondaga where in Scriba's day there was living a pioneer named Joshua Forman. Quite possibly he knew Scriba, certainly he had known of him and one may easily imagine he had the Dutchman's dream somewhat in mind when in February, 1808, he rose in his place in the New York Legislature and moved the appointment of a joint committee to study the feasibility of a canal from the Hudson to Lake Erie. This was an improvement on Scriba's scheme for it gave access immediately to Lake Erie without the portage at Niagara. The committee was appointed and for several years the proposed canal was the main issue in New York State politics. A favorable report was made in 1811 but construction was not begun until six years later. The canal was completed late in 1825, forty feet wide, four feet deep, costing about $7,000,000. Its completion was marked by an elaborate ceremony as well it might have been, for no event in the history of New York since the surrender of British authority was of equal importance. The Erie Canal made the Empire State.

Twelve years after its opening it carried more than 600,000 tons of freight or nearly half as much again as all the Mississippi steamboats delivered at the wharves of the Crescent City. This figure was practically doubled in the succeeding ten years and doubled again in the next fifteen. The growth in tonnage was a fair measure of the growth in wealth and population of the cities it served and of the countryside economically tributary to them. New York City outstripped its greatest rival, Philadelphia, and in 1830 reached the position of preëminence in population in the western hemisphere which it since has held uninterruptedly, and as commerce on the Ohio gave birth to Pittsburgh and Cincinnati and Louisville, so the Erie Canal created along its route the cities of Utica, Syracuse, Rochester and many other smaller but thriving towns. An extension to Oswego made that city an important grain shipping port after the Canadians had built their Welland Canal around Niagara and other branches tapping other remoter regions of the state brought to them the advantages of cheap water transportation.

Equally important with its effect upon New York State was the im-

petus it gave toward the growth of the states along the Lakes. Ohio had 500,000 population in 1820 but Michigan and Wisconsin and northern Illinois were still little more than wilderness when the Erie Canal was opened. Chicago was hardly even a small village. But by 1837 there were 3000 boats operating on the canal; leaving Albany almost hourly during the season of navigation and bearing thousands of immigrants and their families on their way to their new homes along the upper lakes. Not only that but it was making it economically possible for them to live there for it was carrying cheaply to the sea their ever growing surplus of foodstuffs and the products of their virgin forests.

It is hard for us to realize the economic revolution brought about by the river steamer and the canal boat. It is estimated that at the dawn of the nineteenth century the average cost of transportation of freight by wagon was about thirty-three cents per ton-mile or $100 per ton from Albany to Buffalo. Only the most valuable commodities could stand such a charge and the carriage of grain or meat more than a few miles from its place of origin was economically impossible. But in 1837 the Erie Canal was charging only seventy-five cents per hundredweight for light and a dollar per hundredweight for heavy freight for this distance or fifteen and twenty per cent respectively of the wagon charge. Rates on the lakes from Buffalo to Detroit were just half the above figures, so that it was possible to carry grain by the water route from Detroit to Albany including transfer charges at Buffalo for about as much as it cost to transport the same commodity by wagon about 100 miles. Passenger travel was also made cheaper and easier. The first class packet fare including meals from Albany to Buffalo in 1836 was $14.52 and by steamer to Detroit $8.00 more.[9]

Within ten years from its opening the Erie Canal was a formidable competitor of the Ohio Valley as a route to the west and its success had stimulated the building of other canals, some of which competed with it while others served as feeders. At the same time, the commerce of the Great Lakes began that growth which is not yet ended and is now one of the transportation wonders of the world. Beginning about the year 1825 an era of canal building set in. Crippled by the financial panic of 1837, it ended about ten years later with the assured success of railroad transportation. It left behind it several thousand miles of canals which had brought population and prosperity to many regions and for the most part financial ruin to their builders. No single transportation factor,

[9] *History of the Great Lakes.*

railroads excepted, has done more toward the growth of the nation than have the canals. Their prosperity ended with the Civil War save in a few instances; but they survived and performed useful service several decades more. The Erie, transformed into the New York State Barge Canal and the Chesapeake and Delaware are the sole important survivors to-day. The others either perform a small local service or, more frequently, lie in ruins, their channels overgrown with forest or levelled by the plow.

The goal of nearly all these artificial waterways was the natural waterway of the Ohio Valley. Farsighted men saw that with the success of the steamboat on the inland rivers the trade of that whole great region was almost certain to go to New Orleans rather than to the cities of the Atlantic coast. In 1825 it was much easier to go from Pittsburgh to the Gulf than to the Atlantic seaboard. Travel east and west across the mountains was difficult, slow, and expensive; but along the smooth liquid highways of the Great Valley traffic flowed easily northwards and southwards. Ideas flowed just as easily and there became evident a growing alignment of the South and West against the East that elected Andrew Jackson to the presidency in 1828. To counteract this trend of trade and to open the developing markets of the old Northwest Territory to the rich cities of the Atlantic coast, New York, Pennsylvania, Maryland, and Virginia built or projected canals from tidewater to the Ohio watershed.

The Erie was completed in 1825. The same year saw the opening of the Schuylkill Canals in Pennsylvania, uniting the waterways of the Delaware and Schuylkill Rivers; and the following July 4, the fiftieth birthday of the nation and the day on which died John Adams and Thomas Jefferson, the construction of the Pennsylvania Canals from the Susquehanna to the Ohio was begun. This ambitious competitor of the Erie was a sort of amphibious enterprise, designed for travel both by land and water. Starting at Columbia it followed the courses of the Susquehanna and Juniata to the headwaters of the latter. There passengers and freight were transferred to inclined railways and hauled over the mountains by steam power and cables. The route took to the water again at Johnstown, following river courses to Pittsburgh. The system was in operation in the early thirties but it never paid even the interest on its bonds, in spite of heavy traffic. The construction of the Pennsylvania Railroad and the panic of 1837 gave it blows that proved fatal.[10]

[10] *Old Towpaths*; also *History of Transportation in America.*

Maryland caught the canal fever and started the Chesapeake and Ohio Canal from Georgetown on the Potomac to the Monongahela in 1828. This enterprise met all sorts of difficulties from the start, not the least of which was lack of local traffic, but it was finally finished to a point about fifty miles beyond Cumberland in 1841. It proved however to have great vitality perhaps confirming the unpleasant theory that a hard time in youth makes for longevity. Anyway, it survived until 1924 when it met death by drowning in the Potomac floods of that year after a long and useful career. Farther south, the James River and Kanawha Canal was completed from Richmond to Lynchburg in 1840. Although it never won through over the mountains it carried a large local traffic and helped to build up its territory and to carry supplies to the Confederate capital and the armies in the Civil War. Sheridan's cavalry did their best to destroy large sections of it but it managed to survive even those able engineers of ruin and to continue with steadily diminishing usefulness until 1880.

At the same period these canals were building, there were also under construction a number of more local waterways, rather coastal than continental in scope. New England built one from New Haven to Northampton, Massachusetts, of which it was facetiously said that the only year it paid dividends was one in which the grass growing along the embankments was harvested and sold. It lasted only a few years. More important were the Delaware and Hudson Canal uniting those two rivers by the help of a portage, the Chesapeake and Delaware, joining the bay and the river and, after radical alterations in profitable use today; the Delaware and Raritan joining New York Bay and the Delaware River and still surviving in a decrepit state; the Morris from Newark Bay to the upper Delaware, which only died in 1924, and a few others of lesser importance.

More important than all of these and second only to the Erie in their effect upon national development were the Ohio Canals, the first waterways to join the Great Lakes and the Mississippi systems. They were begun with great ceremony on July 4, 1825, and were a direct result of the building of the Erie for their promoters saw in these two great artificial systems, joined by the natural waterway of Lake Erie a new trade route from New York to the heart of the fertile Ohio region then suffering from the lack of markets for the produce of its virgin fields. Although uncompleted for more than a decade, these canals were of great influence from the time their first section, that from Akron to

Cleveland, was opened in 1827. One canal, the Ohio and Erie, began at Cleveland, crossed the state in a zigzag, diagonal fashion and joined the Ohio at Portsmouth to which place it was completed in 1832. The Miami Canal made use of the Miami and Maumee Rivers and ran almost north and south across the western side of the state from Toledo to Cincinnati. It was not completed until the middle forties.

These canals which with branches and feeders amounted to more than 400 miles of waterway, were doubtless the greatest single factor in the development of the state of Ohio previous to 1850. Their traffic in 1857 amounted to 1,635,000 tons,[11] consisting mostly of grain delivered at Lake ports for shipment to Buffalo and the Erie Canal, and provisions of other sorts such as meats delivered on the Ohio for shipment to St. Louis or lower Mississippi points. Their economic importance may be gauged from the fact that the year after their completion to central parts of the state the price of wheat rose there from twenty-five cents to seventy-five cents a bushel and it became the common practice to carry grain up to 100 miles by wagon for delivery to canal boats. They also stimulated passenger traffic from New York, from which city it became possible in the thirties to travel to Cincinnati by steamboat, railroad and canal boat in the then unheard of time of eight days. The disturbed times of the Civil War following the completion of railroads across the state put an end to the greatest usefulness and prosperity of these canals but they survived in some sort till early in the present century and the canalized Muskingum River from Marietta to Dresden carried 392,000 tons of freight in 1926.[12] The cost of these canals was immense considering the resources of the state when they were built and from a financial point of view they were successful only for a brief period but their indirect benefit to the state through increase of population and property values was incalculable.

Inspired by these efforts, Indiana built the Wabash and Erie Canal from Toledo, Ohio, to Evansville, Indiana, the longest canal in the United States, 432 miles between terminals. It suffered every conceivable misfortune before its completion in 1857 at a time when it was completely out-of-date. It was closed three years later after a most disastrous history. Michigan projected a great canal system which it was never financially able to undertake but Illinois, helped by the federal government, built a canal connecting the watershed of Lake

[11] Jeans, *Waterways and Water Transport.*
[12] *Report of Chief of Engineers*, 1927.

Photo by United States Engineer Corps.

DAM NO. 9, OHIO RIVER, A TYPICAL REMOVABLE DAM WITH THE WICKETS IN POSITION

When the river is high they are lowered giving an open channel on either side of the permanent regulating works in mid-stream. The navigation lock, used when the wickets are in position, is seen on the farther shore.

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Michigan with that of the Mississippi which endures and forms a partially completed link in the proposed waterway from the Lakes to the Gulf.

Such are the outlines of the canal mania of the three decades ending with the middle of the nineteenth century. It was based on a clear vision of the future in the light then available when railroads were thought impracticable and dangerous; but the towering superstructure unfortunately bore no relation to the foundation of essential cash. Canal building brought states to the verge of bankruptcy but it brought wealth to those fortunate to live near the banks of these four-foot ditches and it brought vividly to the national mind the importance of transportation in our national destiny. Once the railroad was established as a mechanical and financial success it became easy to convince the man who had witnessed the development caused by the slow and crude canals to believe in the necessity of the quickest and cheapest mode of transportation possible. The canals were the godmothers of the railways.

But at the same time rivers and canals were helping to build great and populous states in the wilderness along the Ohio Valley, a greater natural system of waterways to the northward was furnishing a highway to the dark forested lands bordering on the blue water of the Great Lakes. Lake Ontario was isolated by the Niagara Falls and although explorers and traders and missionaries had carried their canoes around the cataract or ventured up the northern tributaries of the Lake, it was Lake Erie that in these decades of expansion furnished the point of departure for the commerce of the upper lakes. La Salle built his ship *Griffin* near the present site of Buffalo in 1679 and sailed her thence into Lake Michigan, dispatching her on a return journey with a small crew on a journey which ended as has the voyage of many another craft, at "the port of missing ships." From then for more than one hundred years there are few records of any vessels save canoes on these lakes but the first push of pioneers after the Revolution brought sails once more to these beautiful yet treacherous waters. There were eight schooners above Niagara in 1800 and steam followed fast after its application to navigation on the eastern rivers. The building of the Erie Canal and of the Ohio Canals stimulated the traffic on the lakes and the filling up of Ohio in turn led to the settlement of Michigan and Wisconsin by the lake route. The first steamer is said to have entered Lake Michigan in 1821 and in 1836 there were 90 arrivals at Detroit. Aroused by the possibilities of lake commerce, Canada had completed in 1833 the Welland Canal between

Lakes Erie and Ontario, eliminating the obstacle of Niagara Falls and making possible with the later canals around the St. Lawrence rapids, an uninterrupted journey from the lakes to the sea by vessels of average size for that period.

The lake ports were seaports before the middle of the last century. The brigantine *Pacific* in 1844 took a cargo of wheat from Cleveland to Liverpool and five years later at the height of the gold rush to California the bark *Eureka* made the voyage from Cleveland to San Francisco by way of the St. Lawrence River and the long cruise around Cape Horn with fifty-nine passengers. The following year the steamer *Ontario* made the trip from Buffalo to San Francisco, the first steam vessel to make the trip from the lakes to the sea. Six years later the steamer *Dean Richmond* took 14,000 bushels of wheat from Lake Michigan ports to Liverpool, leaving Chicago July 14, Milwaukee five days later, and arriving in the Mersey on September 29.[13] The Civil War and the growth in the size of steam and lake vessels to dimensions too large for the canals put an end to this oversea traffic on any large scale, but a local traffic that was to dwarf the tonnage figures of all the oceans of that day was dawning. The first ship lock at the rapids of the St. Mary's River between Lake Superior and Lake Huron was built in 1855 and all the lakes were open to unrestricted navigation. Wheat from Ohio, then from Michigan, then from Wisconsin and Minnesota began to flow down the lakes and coal upwards. Iron ore was discovered on Lake Superior; the lake cities grew to be great industrial centers and need was developed for a waterborne traffic not exceeded today in density anywhere on the seas, the story of which is reserved for a separate chapter.

Rivers, canals and lakes, all contributed to the building of that great empire that reaches from the Appalachians to the Mississippi, and from Tennessee to Lake Superior. First the canoe, then the flatboat and keelboat, and canal boat; finally the steamboat to make the conquest of these inland waters complete. By 1830 it was firmly believed that the future growth of the United States was more largely dependent on waterways than on any other factor. They were the life of the nation. Upon them had been developed a technic of navigation peculiarly adapted to the need, along them a civilization was growing which was thought to be peculiarly dependent upon them. But through these forests that lined their banks and over the mountains which hemmed them in were penetrating the primitive lines of railroad which were at last to overthrow their unquestioned supremacy. It was possible in 1857 to travel from

[13] *History of the Great Lakes.*

New York to Chicago or St. Louis by an all-rail route and before then railroads had paralleled the great canal systems and parts of the river systems. The new method of transport was bitterly fought. Railroads in some cases were forbidden to carry freight; in other cases they were permitted to do so only if canal tolls were charged in addition to the railroad freight; but early in the fifties most of these laws had been repealed and railroad tonnage increased almost yearly at a rate undreamed of even by the railroad builders. Competition on both sides was savage and lawless, but the "Time-Spirit" fought with the iron horse.

And with justice. The railroads filled a place no waterway could approach. They crossed mountains, they penetrated distant valleys, they brought transportation to wherever a compelling need, an effectual demand for it existed. They could be built as cheaply as artificial waterways and were swifter. They carried their terminals to factories and warehouses, eliminating a great deal of trucking. In the end and with all factors considered, they could carry freight in most cases cheaper than waterways did. Their actual freight charges may have been more than the steamboat's or the canal packet's but the difference was more than offset by the other factors just mentioned and they got the bulk of the trade.

Why then have waterways endured at all? Why do they show signs of revival? The answer is found in the fact that just as the railroad filled a need the waterway of those early days could not fill, so to-day the transportation picture has changed, the elements of the problem have altered, and the modern waterway performs a service no railroad can do as well. Far-sighted transportation engineers are seeing yearly farther into the heart of the problem and results are showing that the expensive roadbeds and equipment of modern railways can not under fair competition carry certain sorts of freight as cheaply as a waterway served by modern ships or barges. Shallow canals are as dead as the ox-cart but the bulk freighter of the Great Lakes carries her 10,000 tons of ore or coal or wheat at a rate no railroad can approach, and between these two extremes of inland water transportation efficiency lie such craft as the modern canal barge and the river barge. The essential of any problem is fitting the key to the lock, and the waterway problem is in this respect no different from any other. We must first know the physical conditions to be met and we must find and fit our methods if we can. With the historical picture of the past in our minds we must build our edifice of the future. To try to see how this may be done is the purpose of the remainder of this book.

CHAPTER IV

The Mississippi System

A continent resembles a living organism. It breathes; it is nourished by the rains and the winds; it is stimulated by the sunshine to produce a teeming life that dwells upon it; it exhales; it returns to the sea and the air the elements which have given to it the semblance and to its creatures the reality of vitality; and from these two enveloping reservoirs, drawn into action by the power of the sun's heat, the waters and the air again begin their ceaseless round. As the author of *Ecclesiastes* put it so concisely so many centuries ago, "All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again."

East of the Rocky Mountains, there falls upon the United States during an average year nearly enough water[1] to fill both Lake Erie and Lake Ontario twice over,[2] and enough to fill Lake Huron to within a few feet of its normal level. The greater part of this immense volume of water returns to the air by evaporation or is exhaled by living plants and animals. Some goes into chemical combination with the elements of the crust of the earth or to form living tissue; some is temporarily stored in the ground waters that feed our springs, or held in reserve in our lakes and ponds; but something between one-quarter and one-third of our rainfall flows down our rivers to the sea. Somewhat more than half of this region east of the Rockies drains ultimately into the Mississippi through whose outlets there flows into the Gulf of Mexico during a normal year 150 cubic miles of water,[3] of which the Ohio river contributes about one-third. This mass of water is hard to visualize. It would fill a hole having a surface area equal to that of the District of Columbia and about $2\frac{1}{2}$ miles deep. It would cover Pennsylvania or Virginia, or Ohio or Mississippi to a depth of about twenty feet. It would fill about twenty miles of the Grand Canyon of the Colorado to the brim. It would suffice to make a puddle three inches deep and equal in area to the United

[1] Approximately 6,000,000,000,000 cubic yards.

[2] *Encyclopedia Brittanica*, thirteenth ed., Volume XVI, page 90.

[3] *Floods of the Mississippi.*

States. These figures are for a normal year. In years of flood such as 1927 they may be increased fifty per cent.

In the volume of its flow the Mississippi is only surpassed by the Amazon; its only rivals in length are that great South American river and the Nile each of which is supposed to be about 4000 miles long. Figuring the longest tributary as the main stream, the Mississippi is 4190 miles in length from the Gulf to the headwaters of the Missouri.[4] Above the mouth of the Missouri the Mississippi is navigable for 669 miles;[5] the Ohio has more than 900 miles of navigable water; the Missouri may be navigated at favorable stages more than 2600 miles. The total extent of navigable water in the whole Mississippi basin is estimated as about 15,000 miles.

The Mississippi basin forms part of thirty-one states.[6] Only the New England and Pacific coast states, New Jersey, Delaware, South Carolina, Florida, Arizona, Nevada, Idaho and Utah contain no streams whose waters find their way to the Gulf through the Mississippi. From western New York to Idaho and New Mexico and from Louisiana to beyond the Canadian border, streams run toward this great river that drains 1,250,000 square miles, and along whose banks and those of its tributaries more than half the population of the nation dwells.

Let us try to picture the way it might look to an observer over the central valley say in the neighborhood of St. Louis and high enough to see from the Appalachians to the Rockies and from Canada to the Gulf. In all this region he would not see any rise of ground more than a few hundred feet above the average level of the land except for a limited region in Missouri and Arkansas where the Ozarks break the sea-like monotony. For the most part he would see a level or undulating plain, sloping almost imperceptibly from the mountain barriers east and west toward the muddy ribbon of the Mississippi and bounded at the north by the low divides between the watersheds of the Great Lakes and of Hudson Bay. Could our observer see clearly enough he might discern the whole main system of tributaries which unite to form the mighty river, each with the lesser streams which unite in turn to form them. To catalog or describe all of these would be a task alone requiring a volume, it will suffice to outline those which are of the most importance as navigable waterways.

[4] *Floods of the Mississippi.*
[5] *Report of Chief of Engineers*, 1927.
[6] *Floods of the Mississippi.*

First among these is the Mississippi itself, although above the mouth of the Missouri it is really a tributary of the main stream. It rises amid the forests of northern Minnesota but the head of navigation is marked by bridges below the falls of St. Anthony at Minneapolis. Below this point the river widens to a placid stream, flowing between high bluffs a short distance from either bank and filled with many islands. From bank to bank it averages about a mile wide but sixty-five miles below the Twin Cities it broadens out into Lake Pepin, two to three miles wide and twenty-seven long. The fall of the river amounts on the average to a little more than six inches to the mile except at two points where its flow is interrupted by rapids. The first of these is at Rock Island where the stream drops twenty feet in twelve miles; the other is above Keokuk where the descent amounts to twenty-two feet in eleven miles. A dam for power purposes has been built at Keokuk but locks provide for navigation there and around the Rock Island rapids.

Six hundred and seventy miles below Minneapolis, the Mississippi joins the Missouri and gives its name to the union of the less with the greater stream. But the Missouri, although its drainage basin is greater than that of the upper Mississippi or even than the Ohio, is not as economically important as either of those rivers. The upper Mississippi has now a depth of six feet at low water for all except some forty-six miles of its course;[7] the Ohio has nine feet throughout nearly all its 965 miles to Pittsburgh; but the Missouri in its natural state may be said to exist in two dimensions. It has length and breadth but no thickness. From Great Falls, Montana, where it ceases to be a mountain torrent and becomes a relatively placid river, to its mouth is a distance of 2670 miles. During the summer when the melting snows of the Rocky Mountains help swell its waters, the river is navigable after a fashion for this entire distance, but a depth of more than $3\frac{1}{2}$ feet is not to be depended upon. The current washes the soft soil of its banks and carves out an uncertain and varying course, sometimes half a mile wide but filled with many islands so that the channel is often narrow and winding.

The Ohio is a totally different sort of stream, both by nature and art. Flowing between hills its course only reaches a width of 2500 feet in its lower portion and while the natural channel would hardly exist in the droughts of late summer, its qualities have made possible an artificial improvement of the stream that is one of the notable achievements of river engineering in the world. During low water periods the river is

[7] *Report on Nine-Foot Channel to Chicago.*

obstructed by movable dams which back up the stream into a succession of pools deep enough for navigation, way around the dams being provided by locks. During high water a section of each dam from 600 to 900 feet wide is lowered and shipping has an uninterrupted course except for the locks around the rapids or falls at Louisville where the river descends nearly twenty-six feet in two miles. When the fifty dams projected are all completed the Ohio will have a navigable depth of nine feet at all stages of the river; but even in its present state navigation is impeded by low water for a relatively small part of the year. Averaging the river records for the years 1902 to 1921, the army engineers declare that there was at least six feet of water throughout the whole course of the river during the greater part of the year. For example at Davis Island, four miles below Pittsburgh, there were 260 days of six-foot navigation, at Wheeling 266, at Cincinnati 343, at Louisville 322, and at Cairo where the Ohio joins the Mississippi, 361. The river now has nine-foot depth at all seasons from Pittsburgh to Dam No. 49, near Uniontown, Kentucky, 839 miles downstream. Forty-six dams were completed to and including 1927 and all of the four others projected were building.

Except for the lower Mississippi, the Ohio was the first of our inland rivers to be used for navigation on any large scale and the importance of this waterway led at an early date to projects for its improvement. In 1803 the Kentucky legislature invited the state of Ohio to join with it in a survey of the rapids at Louisville with a view to their improvement for navigation and three years later Virginia joined both of these states in the appointment of commissioners. These three states again united in the appointment of a river commission in 1817 and on the basis of this body's report, Congress in 1824 appropriated $75,000 for the improvement of the river. This work consisted chiefly in the removal of snags and other obstructions which were said in a petition from inhabitants of Kentucky in 1828 to have caused the loss within ten years of nineteen steamboats besides many flatboats and barges, involving the destruction of $1,445,000 worth of property. The first dike was built near Henderson in 1825 and similar structures for narrowing the channel and directing its course were built at intervals until 1844 when all work was suspended on the river until after the Civil War.

The present improvement of the river by the use of movable dams dates from a report by Major William S. Merrill, Corps of Engineers, of the United States Army, after a careful study of this method of river control in France. The distinctive feature of this plan is the

construction of a navigable pass between or adjacent to two or more regulation weirs. The pass is provided with wickets about four feet wide and of a length sufficient to reach from their concrete base at the bottom of the river to the level desired. The wickets may be raised or lowered. In the former position they constitute an effective dam to the current, raising its level to the height projected; but when lowered in times of high water they leave a section 600 to 900 feet wide through which the river may flow unimpeded, preventing the danger of local floods and giving ample room for the great tows of coal barges which are a distinctive feature of Ohio River commerce. Each dam is provided with a lock 110 feet wide and 600 feet long to give passage to river craft, and with two or more weirs for regulating the height of the pool. The first of these structures was opened to navigation at Davis Island late in 1885. Since then forty-six have been completed and four are under construction to complete the plan for slackwater navigation of the Ohio to Cairo whence an eight-foot channel extends up-stream to St. Louis and a nine-foot channel downstream to the Gulf. As we shall see later on, the commerce of the Ohio has increased rapidly in recent years coincidently with the completion of enough of this river improvement to give a navigable river nearly all the year.

The Ohio has many navigable tributaries. Of its two parent streams, the Allegheny is passable for boats of six feet draft for twenty-four miles above Pittsburgh and the Monongahela for 131 miles to a point a little above Fairmont, West Virginia, tapping the great coal fields, and furnishing the greatest single item of Ohio River commerce and perhaps the greatest tonnage for so small a stream that is to be found anywhere in the world. It amounted in 1926 to more than 26,000,000 short tons, of which more than 21,000,000 tons was coal carried downstream. Another important coal feeder is the Kanawha with a depth of six feet for eighty-eight miles.

Most of the navigable tributaries of the Ohio flow into it on its left bank, descending from the mountain regions of West Virginia, Kentucky and Tennessee, and containing larger volumes of water than the streams rising amid the cleared farm lands of Ohio and Indiana. The Muskingum which is improved by a series of dams for ninety-one miles from its mouth at Marietta, is the only important navigable northern tributary. The Wabash, Miami, Little Miami, and Scioto, all formerly navigated, are now practicable only in part and for vessels of very light draft.

But on the left bank of the Ohio we find the Kentucky, the Green,

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Photo by United States Engineer Corps.

HALES BAR, LOCK, DAM AND POWER HOUSE, TENNESSEE RIVER

the Cumberland, and the Tennessee, all of them passable the greater part of the year by boats of less than four feet draft and capable of improvement so that a six-foot depth might be had at relatively small cost. There are 196 miles of five-foot water on the Green and nearly as much on the Barren River. The Kentucky has 260 miles. Nashville, Tennessee, lies 193 miles up the Cumberland which has six-foot navigation from Dam F, forty-four miles above its mouth, to the site of proposed Dam No. 9, 147 miles above Nashville, a total distance of about 290 miles. When Dam No. 52 on the Ohio is completed, six-foot navigation will extend to the mouth of the Cumberland; the final stretch of forty-four miles has now only $3\frac{1}{2}$ feet at low water. The Tennessee, 650 miles long, and forming with its tributaries a system of waterways that steamboats have traversed at some time for a total distance of 1300 miles, is the biggest tributary of the Ohio, but it has at present a dependable depth ranging from one to four feet at low water in open river channels to not less than six feet in the pools of the several navigation dams. The dam at Muscle Shoals is one of them. Chattanooga lies 463 miles up-stream and may be given six-foot navigation by building a few more dams and by narrowing the river channel in places where the more rapid flow would scour it deeper.

Such is an outline of the Ohio River system. It not only brings more water to the Mississippi than any other tributary but it brings more commerce than any other division of the Mississippi basin, its total volume in short tons for the year 1926 amounting to more than 22,000,000 tons as compared with a total tonnage on the Mississippi between Cairo and New Orleans of 14,000,000 tons, which latter figure also approximates that for the total foreign and domestic water-borne commerce for the port of New Orleans for the same year. These figures for the Ohio do not include the 1,000,000 tons of the Tennessee River, the 5,000,000 tons of the Allegheny, the 26,000,000 tons of the Monongahela nor the sum of the tonnages of the lesser tributaries. Next to the Great Lakes, the Ohio River system is the most important chain of inland waterways in North America.

Below Cairo the chief tributaries of the Mississippi are the Arkansas and Red Rivers on the right bank and the Yazoo on the left. The Arkansas enters the great river at Napoleon, Arkansas, 680 miles from the Gulf. While under favorable conditions it may be navigated to Fort Gibson, 640 miles from its mouth, the only section for which statistics are collected is that from the mouth to Morrillton, a distance of 232

miles over which as much as six feet of water may not be counted on for more than one month in the year. The tonnage amounted in 1925 to a little more than 100,000, most of which was logs. This also accounts for nearly all the tonnage on the Yazoo and the Red Rivers although both may be navigated at their high stages for from 200 to 300 miles. Along this reach of the Mississippi are many smaller tributaries whose commerce does not exceed 300,000 tons. The most important of them are the Ouachita and Black Rivers in Arkansas and Louisiana with a traffic of 291,000 tons; the White River in Arkansas with 270,000, and the Big Sunflower in Mississippi with 143,000 tons.

From Cape Girardeau, Missouri, to the Gulf, the lower Mississippi is a tortuous, winding stream, averaging at low water from half to three-fifths of a mile from bank to bank. It flows through a nearly level alluvial plain, from twenty to eighty miles wide, bounded on either side by bluffs rising rather abruptly to heights of about 100 feet. The river twists and turns in its course to such an extent that although the air-line distance from Cairo at the mouth of the Ohio to the Gulf is only a little more than 500 miles the channel of the river measures 1080. Its general course is nearer to the eastern than to the western bluffs, which, after the valley opens out at Cape Girardeau, Missouri, it touches only at Commerce Bluffs and New Madrid, Missouri, and Helena, Arkansas. It approaches closely to the eastern bluffs at Columbus and Hickman, Kentucky, at Memphis, Tennessee, and Vicksburg, Mississippi, and at several points between there and Baton Rouge, beyond which the whole of its natural channel is through alluvial lands on either shore.

The depth of the river is inconstant and variable. At ordinary high water it is often more than seventy-five feet deep in the pools while at low water it may be only a few feet in depth on the many shifting sand bars through which the federal government maintains a nine-foot channel. Below the mouth of the Red River, however, the river deepens due to its increased volume and artificially narrowed channel so that from Baton Rouge to near the outlets the depth is in excess of thirty feet. The river discharges into the Gulf through several channels which were so silted up in their natural state that it was necessary for the Government to build jetties to maintain a depth of more than thirty feet. The jetties narrow the stream which scours out and largely maintains its own channel. Through the whole course of the lower river between Cape Girardeau, Missouri, and Baton Rouge, Louisiana, the channel is a varying quantity as the current is continually breaking through bends,

piling up bars, making and unmaking islands. This action is especially pronounced in times of flood.

Commerce on the Mississippi system began with the first French settlements at New Orleans in 1717 and along the upper river about fifty years later, but there are no statistics on its extent until after the steamboat was well-established. From that time, about 1820, until 1850 the river trade of New Orleans was a fairly accurate measure of that of the whole main stream as New Orleans was the center to which goods were shipped for transfer to local points. The tonnage at this point, exclusive of rafted goods, exceeded 100,000 a year as early as 1818 and in 1841 had mounted to 542,000. These figures do not include articles rafted down the river but only those arriving on steamboats or sailing craft. Steamboats furnished the bulk of this traffic, more than 1900 of them arriving at New Orleans in 1841. Just before the outbreak of the Civil War these figures were practically doubled, marking the high tide of river traffic, until the recent revival. The river commerce of New Orleans exceeded 2,000,000 tons in 1926. The War, the unsettled reconstruction period and most of all the increase in railroads and the trend of trade from west to east rather than from north to south, all helped undermine river commerce. Figures for the upper river are lacking before the Civil War but in 1871 the river commerce of St. Louis according to government figures amounted to 1,600,000 tons as compared with 3,258,000 tons by rail. The river tonnage amounted to 800,000 tons in 1926. Above St. Louis there are no tonnage figures available during the period of greatest traffic, but as from 1921 to 1926 it averaged a little more than 700,000 tons annually, of which the greater part was sand and gravel, there must have been a great decline from its most flourishing era. The same is true of the Missouri. Here again tonnage figures for the early days are lacking but there were seventy steamboats on the river in 1866 while twenty years later there were only seven and three tugs. Efforts to revive Missouri River commerce during the present century have met with little success, tonnage figures falling from 347,000 for the lower river in 1913 to 139,000 in 1921 and rising to about 500,000 in 1925. This is however a step in the right direction.

For the main stream of the Mississippi and for the Ohio the volume of traffic reached a low ebb about the beginning of the present century. The increase then was irregular until after the Great War since which time it has been steady and at an increasing rate. The tonnage figures for the whole Mississippi system in 1889 were in round numbers, 56,000,000;

in 1906, 52,000,000; in 1916, 56,000,000; while for the year 1926 the total volume of this commerce amounted to 77,000,000 tons, not including more than 33,000,000 tons of ferry traffic. This total is nearly 10,000,000 tons larger than for the preceding year. The figures are for total receipts and shipments and necessarily give an exaggerated picture of the true volume of river commerce since many shipments are counted twice. They serve well however for purposes of comparison, if it be noted that ferry traffic was not separately recorded in 1916 and earlier.

But comparisons of separate stretches of the main river, or of tributaries, or of ports set a better standard. For example, on the Ohio, tonnage figures are now derived from the passage of freight through the dams, each shipment being counted but once. These show an irregular decline from 1900 to 1919, the commerce in the former year having been in round numbers, 14,000,000 tons, the highest since 1892 while in the year 1919 it had sunk to its lowest ebb, 5,400,000 tons. From then the increase has been to a high record in 1926 of nearly 20,000,000 tons not including ferries. All the main tributaries of the Ohio show increases in traffic since 1916 but the biggest increase is that of the Monongahela.

This river probably has the heaviest commerce of any purely inland stream in the world. It amounted in 1926 to 26,374,682 tons and has averaged more than 20,000,000 tons since 1922. In 1916 it amounted to about 9,800,000 tons. This huge tonnage, which in 1925 was nearly 92 per cent of that of the Panama Canal, is over 127 miles of stream extending from Pittsburgh to Fairmont, West Virginia, improved with locks and dams, and a navigation season in 1926 of 360 days. The greater part of the traffic is coal, brought from the mines along the river to the steel mills which also border upon it. The river carried more than 20,000,000 tons of coal in 1926 and more than 500,000 tons of ores and metals. The remainder of the tonnage consisted mostly of sand, gravel and coke.

Turning from the Ohio system to the main stream of the Mississippi, we note a smaller rate of increase in the river traffic as measured by the commerce of the principal ports. That of St. Louis which in 1906 amounted to more than 700,000 tons, fell off to 154,000 tons ten years later and only exceeded the 1906 record in the year 1926. The river trade of Memphis shows a similar trend, falling from 662,000 tons in 1906 to 287,000 tons in 1916 and thereafter rising quite steadily to a high figure of 837,000 tons in 1925, declining in 1926 to 777,000. The river commerce of Baton Rouge has grown from 15,000 tons in 1906 to 8,900,000 tons in 1926, the greater part of the increase being due to oil ship-

ments in deep draft ocean ships. New Orleans has approximately doubled its purely domestic river traffic in twenty years, the figures, excluding ferry traffic and that going down river to coastwise points, having increased from 1,036,613 tons in 1906 to an average of a little more than 2,000,000 tons in 1925 and 1926. The foreign commerce of the port began to increase after the completion of the Panama Canal, the total of more than 10,000,000 tons in 1926 comparing with a little under 2,000,000 tons of ocean and coastwise freight nineteen years before.

If we make the conservative assumption that every ton of river commerce in the whole Mississippi basin is counted twice in the grand total of 77,000,000 tons, exclusive of ferry traffic, given by the Corps of Engineers as the traffic volume for 1926, it would require to move this traffic 770,000 freight cars of 50 tons capacity which is about ten per cent greater than that of the average freight car; or, assuming 100 cars to the mile, it would require a freight train 7700 miles long of maximum capacity. Actually the average freight train in 1925 hauled 693 tons, so that it would have required 55,555 such trains to have moved this tonnage.

Let us now see what this huge amount of traffic consists of and its main routes of travel through the Mississippi basin. In the first place ninety-four per cent of it is bulk freight, that is, freight not shipped in separate containers. Of this bulk freight the greater part consists of coal, sand, gravel, ore, rafted logs and lumber. On the Mississippi below Baton Rouge and on the Kentucky River, crude and refined petroleum is an important part of this bulk freight, and it is becoming increasingly so on the Ohio. On the Green and Barren Rivers of Kentucky, rock asphalt contributes more than half the tonnage of bulk freight, and on the Mississippi below St. Louis, grain is an important bulk commodity.

Most of this bulk freight is not carried far. Sand and gravel seldom gets much more than out of sight of the pit from which it was dug, on the Ohio for instance the average is only $11\frac{1}{2}$ miles. Rafted logs on the upper Mississippi and on the upper waters of the rivers of Kentucky and Tennessee are carried farther. Coal is carried farther yet and wheat the farthest of all these bulk commodities, nearly all grain carried down the Mississippi going through to New Orleans for export. Right here it may be said that on the lower Mississippi the proportion of bulk to total freight is smaller than on either the upper river or the Ohio, amounting to about sixty-six per cent of the traffic between St. Louis and Vicksburg,

below which point it is again increased by petroleum shipments to and from Baton Rouge. On the Ohio, bulk freight forms ninety-five per cent of the total while on the Missouri below Kansas City the total movement of package freight amounted in 1925 to only two tons.

This is not to say that bulk freight is not as important as package goods. It pays less but by providing essential raw materials at low cost it performs a valuable service. One of the greatest factors in the industrial supremacy of the Pittsburgh iron and steel district is the Monongahela River, which brings coal directly from the mines to the mills without trans-shipment. It is interesting to trace the movement of this coal down the river. Of the 21,700,000 tons floated in 1926 on the Monongahela and Allegheny Rivers, of which the latter contributed less than 800,000, only 8,230,000 tons appear in the Ohio River traffic figures. The rest of it was used at or above Pittsburgh. The Great Kahawha carried nearly 1,200,000 tons of coal and the other tributaries of the Ohio about 100,000 tons more; but the consumption of the towns along all these streams is greater than the production and the tonnage of coal floated past Cairo down the Mississippi amounted to only 81,000 tons. Coal receipts by river at New Orleans were 5644 tons. It is interesting to note that coal, like water, does not run uphill. Although it is not as far from the mouth of the Ohio to the great market of St. Louis as it is to the lesser towns of the lower valley, only 2437 tons of coal are reported as arriving there by river in 1926.

In general it may be said that at the present time, the only river commerce in the Mississippi basin that has any more than local importance or contributes materially to the national production and distribution of goods, is that of the main stream of the Mississippi below St. Louis and that of the Ohio and the Monongahela. The commerce of the other rivers in the basin, including the mighty Missouri, is at present little more than that of gravel pits, of log rafts, and of districts either remote from a railroad or favorably situated on the shore of a navigable stream. That is not to say that there is not a large potential commerce contingent on the development of these other streams. Past experience teaches this is not the case, especially on the lower Mississippi where the remarkable record of the government-owned and government-managed Inland Waterways Corporation has indicated what use might be made of our rivers by the employment of modern methods of river improvement and transportation.

The Inland Waterways Corporation is a child of Mars, brought up and

nourished by its combative parent who has come to believe that this one-time puny infant will grow to lusty manhood. When the federal government took over the railroads during the war, an Inland and Coastwise Waterways Service was organized to conduct the operations of the new Barge Canal in New York, various government coastwise canals, and barge lines on the Mississippi and Warrior Rivers, the latter extending from near the steel district of Birmingham, Alabama, to Mobile. Post-war conditions found these adopted children of Uncle Sam in a perilous condition. The New York State Barge Canal was taken from under federal control and the operation of federal barges thereon ceased. The Mississippi-Warrior line was trying to make something out of nothing and with antiquated materials. Its equipment of barges and tugs was futilely inappropriate and inadequate. Traffic was nearly non-existent. It looked not only as if the experiment were to be a ghastly failure but as if it would seal the doom of any attempt to revive river traffic for decades to come. With a total revenue of $2,846,000 in 1923 there was an operating deficit of approximately $1,000,000.

At this disheartening juncture the Army Engineer Corps, which was in charge of operations, advised the formation of a corporation to take over the operation of the Mississippi-Warrior service. This corporation was to be financed by the issuance of $5,000,000 capital stock, all of which was to be held by the United States government which was to detail officers from the Corps of Engineers to manage the enterprise. Congress passed the enabling act and the Inland Waterways Corporation was formed. It had a discouraging start but its executive officer and chairman of the Board, Major-General T. Q. Ashburn was not discouraged in spite of public ignorance and apathy and the keen and hostile interest of the railroads.

The equipment of the old Inland and Coastwise Service on the Mississippi below St. Louis in 1921 consisted of ten towboats, forty-eight steel barges of 2000 tons each, and thirty-one terminal and service craft. At the close of 1926 the fleet consisted of fourteen towboats, three self-propelled barges of 1600 tons; seventy-two steel cargo barges of which nineteen are of 3000 and forty-two of 2000 tons; and thirty-seven terminal and auxiliary craft. Much of the earlier equipment was out of repair; the present equipment is of the best.

The old service carried in 1921 on the Mississippi, 443,267 tons of freight; the present service carried in 1926 a total of 1,044,649 tons. More than that however, the increase is in goods showing the possibility

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of river commerce as an aid to industry and agriculture. There is at East St. Louis a great plant for the manufacture of aluminum ware, used all through the Middle West. This plant is in competition with others on the sea-coast and in foreign countries. It has been found that it can effectually compete by bringing ore from British Guiana to New Orleans by sea and thence by water to East St. Louis. The tonnage of this bauxite in 1921 amounted to only a little more than 8000 tons but in 1926 the Inland Waterways Corporation carried 123,000 tons of it up the river. It is not surprising that the fleet carried 172,000 tons of grain downstream in 1926 as that was one of the great commodities on which traffic estimates were based; but it is rather astonishing to note that more than 300,000 tons of sugar were carried up stream that year as well as 28,000 tons of sisal hemp used in the manufacture of binder twine. Agriculture benefited through the transport of 54,000 tons of cotton in 1926 as compared with 32,000 tons in 1921. Products of iron and steel have shown a steady increase from 5000 tons in 1921 to 45,000 tons in 1926 in which year more than 2000 tons of automobiles were carried as against only 690 tons the preceding year. Canned goods which did not figure at all in the earlier reports furnished 37,000 tons of freight in 1926, much of this being shipped from California by the Panama Canal to New Orleans. The third largest item in the freight summary of 1926 was miscellaneous merchandise of which there were carried 166,000 tons.

These high spots in the traffic returns of this youthful transportation agency show that river traffic can be revived; and more than that, that a common carrier traffic can be built up. Much of the Ohio River commerce, particularly in coal, and all the huge lake commerce in coal and ore is by private or contract carriers; that is by vessels owned or leased by large corporations for the transport of goods used or sold by them but not used by the general public for merchandise freight. But on the Mississippi and Warrior Rivers the Inland Waterways Corporation has created a common carrier of great effectiveness and the river is now bearing on its waters more freight than at any time in its history. For the old steamboat carried only a few hundred tons of cargo while the modern barge carries 3000.

This trade has been built up by the use of suitable vessels, by the balancing of cargoes up and down stream and the attraction of high rate merchandise through the use of a fast packet service. Of essential importance have also been joint rail agreements with railroads so that during 1926 freight carried by the line had its origin or destination in

forty-one states. Modern terminals have also been a factor, and probably more than all and as a result of all, a rate structure averaging twenty per cent under that of competing rail lines. It is estimated by General Ashburn that the direct saving to shippers on the Mississippi amounted in 1926 to an average of $1.75 on every ton of freight or a total of $1,828,135.

The success of this enterprise has led General Ashburn to believe that the way is now open for private capital safely to invest in common carrier transportation on the lower Mississippi and that the time is soon to come when the same thing may be said of the upper river. It has stimulated residents of the cities of the upper valley to the organization of a company to engage in river traffic, whose facilities the Inland Waterways Corporation leased and with which and others of its own it began operations in the summer of 1927. This line extends from St. Louis to Minneapolis. It requires a different type of boat from those used on the lower river for the depth at low water at many points in the upper stream does not exceed four feet while there is eight feet from St. Louis to Cairo and nine feet below that point.

Furthermore there is developing a movement toward the operation of common carrier vessels on the Ohio River system and on the Missouri, the beginning on the latter being partly dependent on the improvement of the stream. Not wholly though for the experiments of the Inland Waterways Corporation have stimulated experimentation in vessels adapted to the river rather than waiting for the river to be adapted to the boats. This project is as yet in its infancy but there seems to be a way out of the swamp into which river commerce had fallen, a way based upon modern boats and terminal equipment, and harmonious arrangements with the railroads enforced if necessary by the Interstate Commerce Commission. The outlook for inland river commerce has not been so bright since the day in 1817 when the steamboat Washington completed the first round trip from Louisville to New Orleans in forty-one days. But before its success is assured one important thing must be done. The Mississippi must be bridled.

CHAPTER V

Floods

The Father of Waters has an expansive temperament. Sometime nearly every year his spirit is starved by drought and he subsides to a meek and meandering stream, quiet and placid in the deeper pools or trickling in gentle swirls over sand bars which impede or even interrupt navigation. And nearly every year, fed with copious rains, he swells in his majesty to a great and formidable flood, a veritable sea of flowing waters, tearing out sand bars, overwhelming islands, undermining or surmounting in triumph the obstacles to his course that man has set, bringing destruction to many acres of fertile land and perhaps death to their inhabitants. Ever since civilized men settled along the banks of the Mississippi they have tried with varying success to control this mighty river. Whether or not they will eventually succeed, time may tell. It is a problem too large to be solved in a year or a decade; but it must be considered and in order to consider it we must first see how these floods happen. Diagnosis must always go before a rational cure.

The ultimate cause of all the Mississippi floods is the Gulf of Mexico. From that vast reservoir of tepid water, warm southerly winds bear toward the colder north immeasurable cubic miles of moisture-laden air. Air that is warm can carry many times more water than can cold air and when in winter these almost saturated winds blow northwards across the cold land or are chilled by their forced ascent of mountains or by climbing over dense masses of cold surface air, the water they bear is condensed as rain or snow to fall upon some part of the Great Mississippi Basin. If there was no Gulf of Mexico or if a range of high mountains along its northern shore caught and condensed the moist winds from its surface the present valley of the Mississippi would be as arid a waste as is the far interior of Australia where coastal mountains prevent all but a little of the moisture of the surrounding oceans from penetrating to fall as rain. The predominant part played by the Gulf in the rainfall of the Mississippi Valley is seen in the way the amount of that fall diminishes as distance from the Gulf increases. The normal year's precipitation at New Orleans amounts to about sixty inches, at Memphis to fifty-two inches, at Cincinnati to forty-two inches and at Pittsburgh to only

thirty-six inches. In the extreme upper Mississippi Valley it averages close to twenty-five inches while along the headwaters of the western tributaries of the great river it sinks to that of a semi-arid region, averaging from ten to fifteen inches a year.[1] These figures of course include melted snow measured as rain. It is important to note that the heaviest rainfall is in the lower valley and to remember it when flood prevention measures are discussed.

This varying amount of rain falls upon land of varying character. Some of it, such as that of the upper Missouri valley, is nearly always dry and able eagerly to soak up large amounts of water. Some of it, in the bayou region of the middle and lower valley, is almost saturated with water. Along the tributaries of the Ohio we find steep mountain slopes more or less denuded of forest and subject to heavy winter rains; along the upper Mississippi and throughout the states of Iowa, Nebraska, Kansas and much of the Dakotas, we find nearly level farmlands; in the southwest parts of the Great Basin we find something approaching deserts. As a result of the diversity of this vast terrain the proportion of water that runs down the rivers to that which falls from the sky varies greatly. For the whole basin it is very close to twenty-five per cent; but in the relatively dry region of the Missouri valley where water is more quickly evaporated and more avidly absorbed it amounts to but fifteen per cent, while the wet lands of the lower Mississippi region discharge into the river approximately fifty-two per cent of the annual rainfall. The great valley of the Ohio, which contributes nearly one-third of the total discharge of the Mississippi basin, has a proportion of run-off to rainfall of thirty per cent while that of the upper Mississippi valley amounts to more than twenty-seven per cent. These different proportions of run-off to rainfall combined with the varying amounts of rain received in the various regions of the basin, result in so affecting the total run-off from the principal regions tributary to or part of the main stream that their volumes bear little relation to the relative areas of these subsidiary basins. For example, the Missouri basin is the largest of all these subdivisions yet its average annual discharge of 132,000,000,000 cubic yards of water is only about half of the volume discharged by the Ohio. The upper Mississippi is only a little less heavy in average volume than the Missouri although the area of its basin is far smaller, and both of these are exceeded in run-off by the central region of the Mississippi whose many small tributaries and myriad acres of swamp lands discharge

[1] *Elements of Flood Control*, Col. C. McD. Townsend.

a volume of water only exceeded by that from the Ohio. The figures in billion cubic yards a year are for the Ohio, 230, upper Mississippi 125, Missouri 132, Arkansas 74, Red 66, Central Valley 157; the total for the whole basin above the Red River amounting to 718,000,000,000 yards. This and the 66,000,000,000 contributed by the Red flow out into the Gulf through the mouths of the Mississippi and through the Atchafalaya and La Fourche Bayous which latter take in normal years about 60,000,000,000 yards of the total, leaving 725,000,000,000 yards to flow out of the passes of the Mississippi. This is equivalent to about 516,000 cubic feet per second.[2] In periods of low water the discharge amounts to but about one-fifth of this; when it amounts to more than 1,000,000 second feet, the Mississippi goes over its banks and there is a flood.

Just as day follows night, and harvest the seedtime, so the normal flow of a river runs in definite cycles. All the great tributary basins of the Mississippi follow this rule, all have their normal periods of high and of low water and the result of their combined flow down the Great Valley is a yearly pulsation of the waters, a rise and fall of the breast of the great organism which has been measured and studied. Fortunately for the valley, the normal high water periods of the great tributaries do not coincide for when those of more than two do a flood is almost certain. The great flood of 1927 was due to floods from twelve of the larger tributaries of the Ohio and the Mississippi arriving in the lower valley at about the same time. Yet it is estimated that the maximum discharge of that flood was not over 3,000,000 cubic feet per second while the combined maximum discharge of the main stream and all its tributaries is one-third as much again.

The normal high water period on all the tributaries is sometime in the first half of the year. The first important river to rise is the Ohio. The winter rains begin to swell its volume even in December and it rises steadily until the latter part of January. The severity of winter, then at its greatest rigor, ties up some of its feeders with ice and diminishes run-off for a few weeks so that a slight fall is normally noticed early in February. Then a quick rise starts, resulting in the highest stage of the year about the middle of March. The Ohio remains high until mid-April when a fall sets in to continue until the lowest water of the year in August. Owing to the steep banks of the main stream and many of its tributaries and the location of the valley where a fairly heavy rainfall culminates at the end of winter when the greatest amount of snow is on

[2] *Floods of the Mississippi.*

the ground, the Ohio is of all the main tributaries of the Mississippi, the most subject to floods.

The upper Mississippi, rising in a land where spring comes late and the rainfall is not so heavy, is slower in rising. At Keokuk it has a single moderate swell culminating about May 9, and falling steadily thereafter until late in the summer when it arrives at a low level maintained throughout the winter. Floods in this region of the river are infrequent and are never severe enough in themselves to cause floods in the central or lower valley.

The Missouri, whose headwaters lie amid the snows of the high slopes of the northern Rockies, hardly begins to stir itself until June. There may be a slight rise in the lower river in April from the spring rains, but the great freshet does not come until the summer sun is strong enough to melt the mountain snows. The river is usually running nearly bank-full in June and continues at a fairly high stage until midsummer.

The Mississippi below the mouths of the Missouri and the Ohio is the lair of the floods. It is now getting into the region of swamp lands and heavy winter and spring rains which begin to swell its current as early as January. It feels the effect of the normal high water from the Ohio and reaches a maximum stage about mid-April, the decline from which is checked in May along its northerly reaches to a slight extent and in June to a greater extent by the rises of the upper Mississippi and the Missouri. In normal years this spring crest moves steadily down the river at the rate of about thirty miles a day, flattening out on the way so that the minor tributary crests merge into one another and at New Orleans show only as a single annual pulsation of the river which normally reaches its maximum in May.

The lower western tributaries of the Mississippi are usually[3] individually unimportant as contributors to flood stages of the main river but their combined effect is so potent that it may be truly said that a moderate flood or at least a bank-full stage is the normal stage of the lower river in springtime. If then a flood comes out of the Ohio either due to that stream or to its larger tributaries, a serious inundation will result on the lower river. That has been the cause of all the great floods of recent times, notably that of 1927. Nearly every flood of the Mississippi has been due primarily to an Ohio flood superimposed upon high

[3] The Arkansas and White Rivers in 1927 discharged together about 1,200,000 cubic feet per second, or about 60 per cent of the flood flow of the Mississippi past Cairo.

water in the lower river in which neither the Missouri nor the upper Mississippi is capable of causing an overflow. The part played by the western tributaries in 1927 although unprecedented was foreseen as a possibility by Prof. H. C. Frankenfield of the United States Weather Bureau, who, discussing the flood of 1912, wrote:

"Fortunately the lower western tributaries thus far do not appear to have played an important part in flood causation; yet the possibility of simultaneous floods in both the eastern and western tributaries and in the main stream is ever present; and should this condition arise, the resulting stage between Cairo and the Gulf would probably be higher than the highest yet recorded."[4]

When 2,000,000 cubic feet of water a second are flowing down a stream bed which can accommodate only 1,000 000 there is quite certain to be a flood. Nothing can prevent it except levees built some distance back from the natural channel, or dams which will hold back the water, or spillways which will permit it to run off quicker to the Gulf. In those three alternatives we find the germ of every method of flood control that has been suggested for the Mississippi. Levees have been built along the alluvial plain since the settlement of New Orleans in 1717 and their construction is the only one of the three methods that has ever been tried on a large scale. The only flood control dam of any size in the whole Mississippi basin is that of the Miami Conservancy District, constructed after the disastrous Dayton and central Ohio floods of 1913. The only spillways have been temporary expedients such as the cutting of levees in flood time. But up to the end of 1926 there had been built along the Mississippi Valley from a few miles above the Passes to where near Cape Girardeau the river emerges upon the level alluvial plain, 1815 miles of levees.[5]

Levee construction for more than one hundred years was by the owners of land along the river. That method was found inadequate and was succeeded by the formation of levee districts which taxed themselves to build and maintain the works. By 1844 levee construction extended up stream to Napoleon, Arkansas, on the west and to the Yazoo delta on the east bank. The Civil War brought ruin to the levee system which the poverty-stricken South was unable properly to repair. Then came the great flood of 1874. Commissions had been appointed by Congress during the preceding fifty years to study the control of the river, of

[4] *Floods of the Ohio and Mississippi Rivers.*
[5] *Report of the Mississippi River Commission,* 1926.

which the most notable had been that of Captain Humphreys and Lieutenant Abbott of the Engineer Corps of the Army, submitted just as the Civil War broke out. This report had considered cut-offs, diversions of tributaries, and reservoirs and had decided against them all and in favor of stronger levees.

Following the desolation of the flood of 1874, Congress appointed a commission headed by General G. K. Warren. This commission reported the following year in favor of federal aid in the building and maintenance of levees and after prolonged debate in Congress the Mississippi River Commission, a body which still functions, was created by Congress in 1879. It is composed of army and civilian engineers and prominent citizens of the valley and has charge of all improvement of the river from the head of passes to the mouth of the Ohio.

The Commission began building levees in 1882, after the great flood of that year, and up to the end of 1926 the federal government has expended through it for levee construction and repair $67,759,882 from government and $13,188,862 from contributed funds, while state and local organizations have contributed a little less than $148,000,000, making a total of a little under $229,000,000 spent for levees in forty-five years.[6] The first improved levees were measurably successful and when in 1898 a fair sized flood poured down the valley to the Gulf without a break in the system it was hoped that the problem of the Mississippi had been solved. Since then, however, in spite of even higher and more massive levees there have been higher and more disastrous floods, culminating in the prodigious disaster of 1927 which destroyed property perhaps equal in value to the whole sum spent for levees in half a century, the destruction being the greater because the false sense of security due to levee building had inspired a remarkable agricultural development in the alluvial plain, which in turn had doubled the area of cultivated land and trebled its value in the first thirty years of federal levee construction.

While probably the majority of river engineers still favor levees as the principal method of river control, people at large are wondering if some other method might not be applied. Alternatives are said to be reservoirs, reforestation, and artificial channels, spillways, or the short-circuiting of tributaries to other outlets. Reservoirs are not so simple a solution as might at first appear. It has been estimated that to have held back the flood of 1912 at Cairo would have required a reservoir covering 7000 square miles or about as large as Lake Ontario and nearly

[6] *Report of the Mississippi River Commission*, 1926.

as large as Massachusetts or New Jersey.[7] Land and improvements in the Mississippi Valley may be conservatively valued at $200,000 per square mile so that the cost of the property required would amount, even if condemned for considerably less than its valuation, to more than $1,000,000,000. That is for a reservoir fifteen feet deep, to level the site of which would require moving of enough dirt to build a levee system 7000 miles long and 150 feet high.[8]

The substitution for one great reservoir of a number of others along the important feeders of the Mississippi would merely divide and distribute the problem. Such reservoirs would be of little use on the upper river or on the Missouri, for as has been seen, the floods of those rivers in themselves are not sufficient to cause serious floods along the lower Mississippi and therefore the prevention of Missouri floods or those on the upper reaches of the main stream would not prevent floods below the mouth of the Ohio. Reservoirs along the Ohio or its principal feeders big enough to hold back flood waters would be enormously expensive, especially if they were large enough to hold back the flood water until the normal low stage of the river. If they were not big enough for this purpose they must discharge their overflow not long after the crest of the flood has passed, thereby it is true reducing the height of that crest, but at the same time prolonging its duration and all the loss and inconvenience that continued moderately high water causes. Reservoirs along the lower valley are out of the question because even if it were possible from an engineering point of view to build them on the soft, alluvial soil, they would, if effective, cover almost as much land as is inundated in a severe flood. There is little question but that reservoirs in the Ohio basin, in the upper Mississippi valley and in that of the Missouri might somewhat reduce the extreme heights of floods, but in themselves alone they can never prevent them except at a cost which would make that even of the 1927 flood seem small.

It has been said by many authorities that the deforestation of the Mississippi basin has caused floods and reforestation has therefore been advocated as a remedy. The quite generally observed fact that average stream levels in the region of the great natural virgin forest of North America have fallen since that forest has been nearly all cut down has led to the curious conclusion that if the forests were restored the floods would be not so severe. This belief is based on the capacity of forests

[7] *Elements of Flood Control.*
[8] *Elements of Flood Control.*

to conserve moisture and rainfall by diminishing the rate of run-off from the surface in times of heavy rain, the excess being stored in the humus and sub-soil to be discharged later as ground water and so to raise the level of the streams in periods of scanty rainfall. This belief is almost generally accepted by foresters and river engineers but it does not follow from it that the saturated humus of the forest floor and the saturated soil beneath would, after a prolonged period of wet weather, hold back the run-off from a period of excessive rain much better than would a denuded hillside or cultivated farm land.

As a matter of fact the two greatest floods of the Mississippi as measured by the height of the water were those of 1844 and 1785 when, especially at the earlier date, forest cover abounded. Recent floods have been higher than those of a quarter or a half-century ago but it seems that the greater cultivation of the land in that interval has had as much effect as deforestation. During the present century especially there has been a great movement among the farmers of the lower lands of the valley toward the better drainage of their farms. This water, which used to lie on their land or to soak in until late in the spring, is now made to drain off quickly into some neighboring stream and so into the Mississippi system.

Even if it be assumed that reforestation would restrain run-off from denuded land fifty per cent, an excessive and unwarranted estimate, it may be seen by a little calculation that the amount of forest necessary to prevent a flood in time of excessive rain would be so great as to compare with the area of overflowed land. A forest would however be a paying enterprise, but when everything is said, it seems certain that only a moderate reforestation is possible of the Mississippi basin and that this would never alone suffice to prevent floods. Nor could any relief from this source be had for many decades.

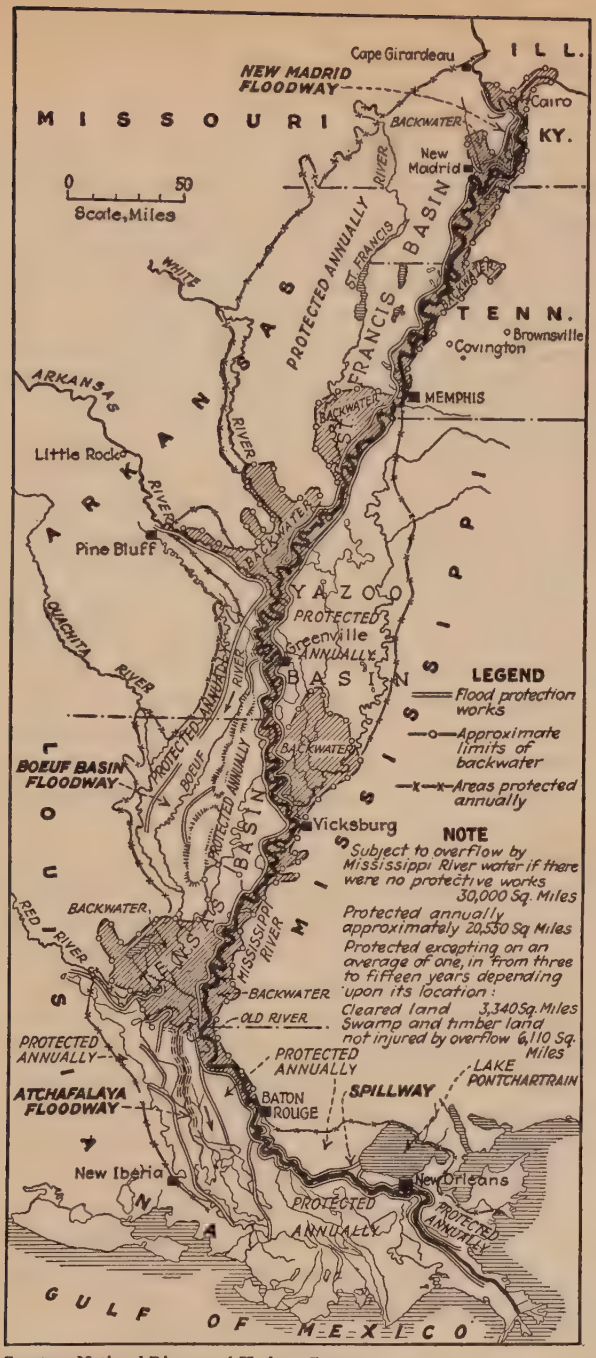
There remain, as proposed methods of flood control, various plans for controlling the channel of the river by the building of artificial channels or spillways or by short-circuiting the current either by cutting off the bends or by diverting tributaries to other watersheds in the way that the Chicago River has been diverted by that city to flow eventually into the Mississippi instead of the Great Lakes system. This diversion by the way has been blamed among other things for the recent Mississippi floods. As its maximum emergency flow in times of sudden excessive rain is not more than 15,000 cubic feet per second it is not likely that it would contribute much to a flood at Cairo of 2,000,000 second feet.

It has been suggested to build a practically new channel of the Mississippi from near Cairo to the Gulf, to divert the Tennessee into the Tombigbee River of Alabama, or the Red into the Sabine, and it has been proposed to build emergency spillways of the great river at various points above and below New Orleans. These are all questions for engineers to decide and not the author of this book. Suffice to present a few problems which such a program must face. It is evident that if a large tributary of the Mississippi or a large part of its own course be diverted through new courses or through those of smaller rivers, that these new channels must themselves be protected by levees or some other measure of flood control. It is also evident that if by cutting off the bends the flow of the main stream be accelerated, the upper valley will be relieved while the lower basin will have a worse problem than before. Finally, it is argued that the construction of spillways would lower the velocity of the current below the outlet of the spillway and so cause the silting up of the channel to the detriment of navigation in times of low water. This argument is controverted by competent engineers but inasmuch as the great river bears down to the Gulf some 400,000,000 tons of earth every year, it seems worthy of consideration.

The comprehensive plan for the control of the river below Cairo submitted by Major-General Edgar Jadwin, Chief of Engineers, United States Army, in the fall of 1927, following a flood control investigation made after the flood of that year by the Engineer Corps, gives no place to reservoirs but relies wholly on a combination of levees, diversion floodways, and spillways. It states that the utility of reserviors is wholly in the tributaries of the Mississippi where they might have an effect in somewhat mitigating a flood. The only practicable treatment of the lower river is declared to be the moderate strengthening of existing levees and their relief in times of great floods through the discharge of part of the excess water through emergency exits.[9]

Aside from river-bank floodways back of existing levees between Cairo and New Madrid which would merely have the effect of setting back the levees in times of extreme flood, and a short emergency spillway at Bonnet Carre just above New Orleans, the plan is essentially that for an auxiliary, independent, and emergency channel of the main river from the mouth of the Arkansas River to the Gulf of Mexico, a distance by the main channel of about 680 miles. This diversion floodway as it is called would branch off from the west bank of the main channel and

[9] *Jadwin Report*, 1927.



Courtesy National Rivers and Harbors Congress.

MAIN FEATURES OF FLOOD-PROTECTION SYSTEM PROPOSED BY ARMY ENGINEERS

Line broken by crosses indicates boundary of permanently protected area. Diagonal shading indicates areas at lower ends of flood basins submerged by backwater in occasional years.

Note the river-bank flood channel from Cairo to New Madrid, the wide floodways through the Boeuf-Tensas and Atchafalaya basins and the spillway into Lake Pontchartrain above New Orleans.

would lead through the present course of the Boeuf River on the western side of the Tensas basin, thence along the course of the Tensas River to the Red River and thence by way of the course of the Atchafalaya to the Gulf of Mexico. The plan involves the building of levees to control the course of this emergency stream which would be in times of great flood from five to fifteen miles wide and spreading out at the Bayou des Glaises where the Tensas joins the Red into a backwater lake perhaps twice as wide. The floodway would be at an average distance of ten to twenty miles west of the main stream of the Mississippi. It would only be used in great floods.

Without any levees, there would be 30,000 square miles of land subject to floods below Cairo, two-thirds of which was inundated in 1927. Under the proposed plan, approximately 20,000 square miles would be forever protected against a super-flood resulting from the simultaneous arrival in the valley of maximum floods from all the tributaries. Such a flood would be from three to six feet higher than the one of 1927. Of the remaining 10,000 square miles, about two-thirds is swamp and timber land, untillable, largely uninhabited, not damaged by overflow. All of this and all the 3300 square miles of arable land subject to overflow, would be protected against inundation from two years out of three to fourteen years out of fifteen depending on location, nearly all the high grade land receiving the best protection.

In addition to these flood ways capable of carrying off great volumes of water from the main stream it would also be relieved by setting back the levees at points where in times of flood the channel is too narrow for the vast volume of water. The spillway above New Orleans would lead into Lake Pontchartrain and would only go into service when a mammoth flood such as that of 1922 or 1927 threatened the levees around the city. The channel would be further protected by revetments of the banks to prevent caving, and present levees would be strengthened and raised in places to a maximum of three feet above present heights.

The cost of the whole plan from Cairo to the Gulf of Mexico is estimated by General Jadwin at $296,400,000, and it would take about ten years to complete. The economic justification for such a huge expense may be summarized in the statement that the estimated 1927 value of all the land, improvements, and movable property in the area subject to flood is $5,000,000,000, while the cost of the 1927 flood is put above $200,000,000.

Levees, reservoirs, forests, cut-offs, spillways; these are the only known

means for controlling the swellings of this mighty inland tide that bears in it the capacity for such widespread and terrible destruction. The chief objection to levees is that they have been tried and have sometimes failed and that by confining the course of the river they make necessary for every addition to the completeness of its drainage an addition to the height of the levees. This objection is met by the floodways provided under the Army Engineers' plan. It is also said that the river raises its own bed between the levees and so requires them to be progressively higher. They were only four feet high at first; they are now in many cases over twenty, and the flood of 1927 was the most destructive if not the highest of record.

That the river raises its own bed between levees is denied by competent engineers, in fact the weight of engineering opinion seems to be rather the contrary but there is no doubt but that levees are higher and in the absence of floodways have to be. This seems to be due to the better drainage from deforested slopes and from improved farm land up-stream and from the perfection of the levees themselves which do not permit so often as before the lowering of the levels downstream through wholesale breaks or inundations above.

But the main cause of all the floods is rain. It is the only real cause. If more of it comes down, more of it must run off. If the excess amounts, as it did in 1927, to twelve inches or more in three months over a great part of the basin, the additional amount of water flowing down the big river is going to tax the skill of the best of engineers who try to control and direct it. It seems probable that it will be best controlled by a combination of all known methods, with the biggest reliance upon levees and floodways. It will cost hundreds of millions to complete, but when it is done it will ransom from the fear of floods a region nearly half as large as all New England, approximately the size of West Virginia and containing some of the most fertile land in all the world.

CHAPTER VI

The Great Lakes

When Jacques Cartier, in the summer of 1535, sailed a thousand miles up the Gulf and the River St. Lawrence to the present site of Montreal, he thought he might be on the water road to China. The presence of rapids in the river barred his further progress but the idea of China persisted and either he or some near successor called the rapids, "La Chine." The explorers were wrong but, as so often happens, the truth was more wonderful than the exploded theory, and above and beyond the white water whirling swiftly out of the wilderness and the forest lay the road to a system of inland waterways unparalleled in the world, bordered by lands rich in nearly every potential resource needed by civilized man, and destined to nourish and support a civilization more populous than that of any European country of Cartier's day and more wealthy than any then on earth.

For these rapids mark the essential natural boundary between the navigation of the ocean and that of the greatest series of inland seas the world knows. Beyond them lies a water road nearly 900 miles long to the junction of Lakes Michigan and Huron, and extending beyond it 446 miles through the St. Mary's River and across Lake Superior and for 321 miles along Lake Michigan, a total length for the system of more than 1600 miles. It was not in Cartier's day; it is not now a simple navigation for the entire distance. Nature has raised barriers of rapids and shoals, and one of the greatest of cataracts lies straight athwart the path; but man has measurably surmounted these obstacles and has dug a road through these disputed channels, a water road that has opened a coast line of 8300 miles. The Mediterranean was the tideless sea around which our civilization was born and nourished. The New World has in the Great Lakes a parallel to this great landlocked salt sea of the ancients; much smaller in area but not insignificantly so in the length of navigation, while the Great Lakes, our fresh Mediterranean, bear on their blue waters a commerce greater than ever the ancients knew on their sea, and greater perhaps than it bears to-day.

The Great Lakes are a unified and interdependent system, connected by channels and drained by a river whose volume of flow bears so small

a ratio to their total volume or even to that of one of them, that the lakes stand to the channels and rivers as great reservoirs to regulate and make permanent their flow. We have seen how an increased rainfall in the Mississippi basin can cause disastrous floods within a few weeks time and can swell the discharge of the river from 500,000 to 2,000,000 cubic feet per second. An equal increase of rainfall over the Great Lakes basin produces no such effect, the excess being so taken up by the vast surface of the lakes that the rise may be delayed six months or more and will not at most amount to more than a few feet, while an increase of water level of Lake Ontario of three feet, a relatively large amount, will only increase the volume of the St. Lawrence by about twenty-five per cent. Another reason for the slowness of response of lake levels to rainfall is the relatively large proportion of the whole drainage basin of the lakes that is occupied by the lakes themselves, while still other factors are the smallness of tributary rivers and the shallowness of their drainage slopes. The whole system may in fact be considered as part of the St. Lawrence River, whose extremest source, the St. Louis River, rises in western Minnesota, 1870 miles from the Gulf of St. Lawrence.

From there to the watershed of the Ottawa River, the St. Lawrence-Great Lakes system drains about 288,000 square miles of which 95,000 square miles are covered by the lakes themselves, a surface greater than that of the combined areas of New Jersey, New York, and all the New England states except Maine; or of New York and Pennsylvania; or of Georgia and South Carolina; and very nearly equal to that of Oregon. The largest lake, Superior, is very close to the size of Maine, Indiana, or South Carolina; the smallest, excluding Lake St. Clair, is Ontario, with an area close to the combined areas of Connecticut and Delaware. Although all are parts of one vast drainage system, the Lakes divide naturally into four separate units, each on its own level. Farthest from the sea and highest above it is Lake Superior, 602 feet above tidewater. Its waters fall twenty-one feet in their passage through the sixty-three miles of the St. Mary's River into Lake Huron, which with Lake Michigan to which it is joined by the Straits of Mackinac, forms the largest unit level of the St. Lawrence system, the combined areas of the two nearly equal lakes amounting to 45,000 square miles, 13,000 square miles larger than Lake Superior and by far the largest body of fresh water at one level on the globe. The water of Lake Huron discharges through the St. Clair River into Lake St. Clair, a basin of some 500 square miles, so shallow that artificial channels must be used through

much of its extent, and thence by way of the Detroit River to Lake Erie, the total fall from Huron to Erie amounting to only nine feet in eighty-six miles. Beyond Lake Erie comes the one great break in the level of the system, that of the Niagara escarpment where the vast volume of water from the upper Lakes falls 326 feet in the passage of the Niagara River to Lake Ontario, approximately half of this fall occurring at the cataract of Niagara. From the outlet of Lake Ontario, 246 feet above the sea, the St. Lawrence flows as a placid stream with even slope for sixty-eight miles. There a long series of rapids begins, ending just above Montreal, 114 miles downstream and the head of ocean navigation.[1]

The first explorers were quick to recognize the importance of this waterway into the heart of the continent and within little more than a century from Cartier's day trappers, traders and missionaries had traversed it from end to end. All this early voyaging was done by canoe; it was not until August 7, 1679, that the first ship to sail these lonely waters put out from the mouth of the Niagara River where La Salle had been long months building her. This was the bark, *Griffin*, of about fifty tons. There were thirty-four men in the ship's company and the vessel made a fairly good run for a sailing craft, especially in unknown waters, arriving at Mackinac, a distance of about five hundred forty miles, on August 27. Twelve days were spent in making the passage up the St. Clair and Detroit Rivers where head winds and the current combined to make necessary the towing of the vessel from the shore. An amusing feature of the voyage as recorded by Father Hennepin who was on board, was the behavior of the pilot, a deep sea sailor who like some of his modern successors regarded these inland seas with a combination of distrust and contempt.

There was a bad storm on Lake Huron, even La Salle we are told showed fear and began to prepare himself for death as did all the crew except the pilot, who it is related, "did nothing but curse and swear against M. La Salle, who, he said, had brought him thither to make him perish in a nasty Lake, and lose the Glory he had acquired by his long and happy navigations on the Ocean."[2] The pilot it seemed was a good prophet though not of the immediate event. The *Griffin* survived the blow, but, after leaving La Salle and his expedition on the shores of Lake Michigan, sailed back with a cargo of furs in charge of the pilot and five

[1] Lake levels used are the mean of four authorities and are: Superior, 602.24; Michigan-Huron, 581.01; St. Clair, 575.52; Erie, 572.46; Ontario, 246.10.

[2] Hennepin's *New Discovery*.

men, disappeared below the horizon of the great lake and was never seen again save by a few Indians who told later of having tried in vain to dissuade the pilot from his intended course down the middle of Lake Huron.

For a hundred years the development of lake commerce was slow. The wars with the French and Indians, the Revolution, all combined to hinder the settlement of the wilderness. The first American vessel was not built on Lake Ontario until 1798 and two years later there were only eight schooners above Niagara. Nine years after that the first steamer appeared on the St. Lawrence and in 1818 the *Walk-in-the-Water*, first steamer to ply the waters of the upper lakes, was built on Lake Erie, navigating as far as Lake Michigan some three years later. A few years later still the Erie Canal was delivering at Buffalo thousands of emigrants every year, whose destinations were first Ohio, then Michigan, then Wisconsin; and by 1836 there were regular services between Buffalo and Detroit at which latter port there were in that year 90 steamer arrivals. In 1842, the total vessel tonnage on the Lakes amounted to somewhat more than 17,000. It was destined to grow. In 1924 there were 1395 steam and sailing vessels on the Lakes and a total tonnage of 2,791,000 for all vessels of every description. In 1925 there were handled at all lake ports, more than 241,000,000 tons of freight.

But this growth did not come even at first without the removal of some natural obstacles to navigation and the circumvention of others. Compared with the total length and area of the lakes they were few indeed but they were at vital points. From Buffalo to Duluth or Chicago there are today only about fifty-seven and twenty-four miles respectively of navigation through artificially widened or deepened channels. From the head of the St. Lawrence Rapids to the extremity of Lake Superior there is a total of only eighty-seven miles that is not through unimpeded deep water.[3] The lakes themselves are deep, all save St. Clair and Erie having an average depth greater than 250 feet and maximum depths ranging from 750 feet in the case of Lake Ontario to 1012 feet in Lake Superior. Lake Erie has an average depth of seventy feet and a maximum depth of 210 feet while Lake St. Clair is even shallower.

All the obstacles to free navigation from Montreal to the head of the lakes may be classified into four groups. First come the St. Lawrence Rapids, seven in all, extending with long stretches of interspersed smooth water for 114 miles up-stream. Next is the great barrier of Niagara.

[3] *Great Lakes to Ocean Waterways*, page 66.

From the outlet of Lake Erie to the mouth of the Detroit River is open, deep water; but in the eighty-six-mile stretch up that river, across Lake St. Clair, and through the St. Clair River into Lake Huron are a number of reefs and shoals. The final barrier to shipping is the narrow and in places shallow channel of the St. Mary's River between Lakes Superior and Huron and especially the rapids at Sault Ste. Marie.

All these obstacles have been so far conquered by man that it is possible to take vessels drawing thirteen feet of water from the ocean to any important harbor on the lakes. The first barrier to be attacked was that of the rapids of the St. Lawrence. A shallow canal around the rapids between the broadenings of the river known as Lake St. Francis and Lake St. Louis was finished by the Royal Engineers in 1783. No more improvement of the St. Lawrence navigation was attempted until 1815 when money was voted for the building of the canal around Lachine Rapids just above Montreal. From then until after 1875 when all existing St. Lawrence canals were ordered deepened to their present depth of fourteen feet, work went forward with some interruptions on the canals until now there are six with a total length of forty-six miles between Montreal and Prescott. The limiting dimensions of the locks are 270 feet length, forty-five feet width, and fourteen feet depth.[4]

The St. Lawrence Canals had scarcely been begun when the first attack was made on another natural bar to inter-lake navigation, that at the rapids of the St. Mary's River at Sault Ste. Marie. Here the waters of Lake Superior fall about twenty feet in a little more than a mile and here from the earliest days Indians and white pioneers dragged their canoes around the broken water that separated Lake Superior from the combined level of Lakes Michigan and Huron. It was a more important portage in the early days than that around Niagara for the French avoided Lake Erie because of the Iroquois menace and when English traders followed their competitors westward they preferred the relatively easy route by way of the Ottawa River, Lake Nippissing, French River, and Lake Huron to the more difficult if not more dangerous route around the great cataract. So, in 1798 the North-West Company built on Canadian territory a shallow canal around the more difficult part of the rapids. This insignificant precursor of the busiest ship canal in the world served until the war of 1812 when it was destroyed by United States troops and from then until 1855 Lake Superior was an isolated inland sea. The canal of 1855, known as the State Canal, was built on

[4] *Report on St. Lawrence Navigation.*

land donated to the federal government by the State of Michigan. With the rapid development of the "Old Northwest" after the Civil War this one canal became inadequate to handle the increasing commerce of Lake Superior. The ancient copper mines of the Indians along its shores were being developed; iron ore in vast quantities was found; a growing population in a cold climate needed cheap fuel; the scene was set for the most astounding development of water-borne commerce of which the world has record.

The Weitzel lock, wider and longer and deeper than its predecessor, was finished in 1881. It is no longer in use. It had not been finished five years when the Canadians began a new canal and lock on their side of the rapids while a still larger one, the Poe lock was started on the American side, the latter construction replacing the original State lock. Although this new lock was 800 feet long and had twenty feet depth of water, it was seen within little more than a decade after its completion in 1896 that the already huge commerce of the upper lakes required greater facilities. The third lock was begun in 1908 and completed in 1914 and fourth lock was opened in 1919. These are 1300 feet long, long enough to accommodate two of the biggest lake freighters end to end, eighty feet wide, and have more than twenty-four feet of water on their sills. Ships carrying 10,000 tons and more of cargo are locked through in a little more than eleven minutes. All these four locks are in a sense, duplicates as it is only necessary to pass through any one of them to overcome the difference in lake levels. Coincidently with the building of these locks the canal was widened and deepened correspondingly and is now $1\frac{3}{5}$ miles in length. The Canadian canal is about one-third of a mile shorter.

During the interval between the destruction of the first canal at the "Soo" and the building of the "State Canal," the Erie Canal was finished and settlers began to pour into Ohio and southern Michigan. Canadians and British saw that unless the barrier at Niagara was overcome they would get nothing of the rich trade that was developing along the lakes and passing out to sea through the port of New York. Work on the Welland Canal to connect Lakes Erie and Ontario through Canadian territory was begun in 1824 and five years later two sailing vessels were passed through a canal from Lake Ontario to the Welland River at Port Robinson, thence to the Niagara River and so to Lake Erie. That was not however the completed project which, when finished in 1833 permitted traffic for craft 100 feet long, twenty feet wide and drawing a

receipts of grain by lake at Buffalo for the four years ending in 1923 amounted to 192,000,000 bushels as compared with 63,000,000 bushels received by water at Montreal.[6] The Niagara barrier is the greatest obstacle to purely lake navigation today, but it is an obstacle which the new Welland Canal will almost wholly break down.

But above this barrier flows the greatest inland water commerce of the world, a commerce whose volume forms a large part of the total water-borne commerce of the nation, exceeds that of many populous ocean coasts, and rivals that of great maritime nations. On all the lakes, and eliminating all known duplications, the total net commerce of United States ports alone was in 1926 more than 120,000,000 tons and that of United States and Canadian ports, 137,000,000 tons. In the same year the total foreign commerce of all our seaports totaled only 114,000,000 tons, while the sum of all the water-borne commerce of the nation, on the sea, on the lakes, on rivers, canals and connecting channels, amounted to 540,500,000 tons. The total for the lakes in this same year is 10,000,000 tons more than that of the total net commerce, foreign and domestic, of New York harbor and all its tributary ports and channels, and this great total is achieved on the lakes during a navigation season of about eight months. The total ton-mileage of the lake commerce in 1925 was more than twenty per cent of that of all the railroads in the United States—83,000,000,000 ton-miles on the lakes[7] as compared with 414,000,000,000 ton-miles on the railroads.[8] The value of this lake commerce amounts to more than $2,000,000,000 every year.

So much for a general view of the facts. What is of more importance is their significance in the life of the nation, and the significance of this lake commerce is that it consists of the very life-blood of the nation. Up and down those broad blue highways, themselves flowing majestically toward the sea, flow the substances from which in the manner of a living organism our country fashions the very frame of its economic life. From this blood stream of commerce, like that unknown guest who within our mortal frames transforms our food into body and blood and mind, the spirit of our civilization draws the elements to build its distinctive form and character; and from the product of the fields and the mines aided by the mind and the hand of man, constructs a living body, a civilization which in its diversity, wealth, and energy is the wonder of

[6] *Transportation on the Great Lakes.*
[7] *Chief of Engineers Report*, 1927.
[8] *Railway Statistics of United States*, 1925.

the world. This is the Age of Steel; it is the essential skeleton of our civilization, the basis of nearly every machine. But steel means iron and iron means a combination of ore, coal, and the handiwork of man, who himself needs bread to live. These simple substances, iron ore, coal, grain, make up the bulk of this mighty traffic on the Great Lakes; but the seeing eye perceives in the smoke of that almost endless procession of great steamers that thread the channels of the lakes the token of a more complex commerce than that of the rude materials they bear. For as our blood is laden with lime for our bones and protein for our muscles and phosphorous for our minds, and bears the oxygen to give life to the whole organism, so these dingy freighters are laden with the raw material of every machine we make and use; iron for our ships and railroads and skyscrapers and motors and sewing machines and instruments of every sort to magnify the puny physical power of man; copper for our electric nerves; and the golden grain to nourish us all.

This lake commerce flows along a few great trade routes. There is a Red River of ore, a Black River of coal, a Golden River of Grain. Each has its own peculiar course. The river of ore has its springs in the ranges of hills back of the shores of Lake Superior, hills almost literally of iron. From these hills it flows in small streams to the ports of Duluth-Superior, Ashland, Escanaba, Two Harbors. From these and other ports it flows out across the lake uniting near Sault Ste. Marie in a mighty red river that in 1923 amounted to 66 million tons. Beyond the "Soo" the river separates. One branch flows down Lake Michigan to the great steel mills around the southern end of the lake. The main stream continues on through Lake Huron and into Lake Erie where it empties into steel smelters from Toledo to Buffalo or into waiting freight cars that carry it by rail to the hungry furnaces of the Pittsburgh district.

There, in the mountains of western Pennsylvania and West Virginia rises the Black River of coal. Its course is up the lakes, for beyond the cold waters of Lake Superior lies a cold yet busy land. Men need fuel there to live and to work and nowhere within many hundred miles is there a cheap and good supply. So, down from the mountains the railways bring to Lake Erie ports the precious black mineral and there it is poured into the empty holds of steamers that have just discharged their load of ore. Westward and northward they travel, uniting in Lake Huron into a current amounting to 27,000,000 tons in 1923, bearing power and heat and light to the people along and beyond the lakes.

They are the people who produce the grain which forms the third great

river of commerce upon the inland seas. Rising far out on the open prairies, tiny golden rivulets flow from lonely farms in the Dakotas, in Kansas, in the far-off lands of the Canadian Northwest where the barrier of the Rockies lies across the sunset, tiny rivulets that unite at little local elevators to streams that flow down the branch lines of railroad to swell into great tributaries of the golden flood that pours down the lakes. Nearly all the grain that moves by way of the lakes is loaded at four ports. Canadian grain goes chiefly to Port Arthur-Fort William on the north shore of Lake Superior. Grain from the Dakotas and Minnesota goes to Duluth-Superior at the far end of the lake. Towards the eastern end of the lake these branches unite and at the Straits of Mackinac they are joined by another great though lesser tributary flowing up Lake Michigan from Chicago and Milwaukee where grain from the farms of Illinois, Iowa, Missouri, Nebraska and Kansas finds a water outlet.

The Golden River of grain, augmented by this big tributary, flows almost unbroken down Lake Huron and to the far end of Lake Erie. Its volume varies according to the yield of the prairies where lies its source but in recent years it has exceeded 400,000,000 bushels, and in 1922 it amounted to 501,000,000. At the eastern end of Lake Erie its flow divides. The larger part is landed at Buffalo to continue to eastern mills or to the sea by rail or by the New York Barge Canal. Some, as we have seen goes on by water to Montreal; smaller amounts are landed at other Lake Erie ports than Buffalo and go by rail to Philadelphia or Baltimore. An important diversion has already occurred during its passage down Lake Huron where a part of the river finds its outlet by rail to Montreal from Georgian Bay ports. The course of this Golden River is not wholly stopped by the sea for there it flows into the holds of ships that carry it on to the hungry cities of Europe.

Many other commodities than ore, coal, and grain make up the sum of lake commerce but these three have made its greatness and in their relationship with each other illustrate the vital character, the epic quality of this vast trade. Warmed by the coal of Pennsylvania, the people of the treeless prairies produce the grain to nourish the industrial east, which, using the iron ore that also comes down the lakes, produces nearly all the essential mechanical fabric of our civilization. Without this water-borne trade of the lakes, coal in the west, bread and iron in the east, would so rise in price as to require an entire readjustment on a lower scale of our whole economic life. And conversely, if it were possible for this lake commerce to flow uninterruptedly to the sea and for

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LAKE FREIGHTERS ABOUT TO TAKE ON A LOAD OF IRON ORE AT THE ORE DOCKS OF THE DULUTH, MISSABE AND NORTHERN RAILROAD AT DULUTH

The ore is dumped from the freight cars, through the chutes into the vessel's hold

the commerce of the oceans to ascend the lakes, it would open a wholly new chapter of national development, for on its material side, the history of civilization is the history of transportation.

The growth of this vast lake traffic has resulted in the development of a shipping fleet of unique quality. It is not as large a fleet as it was fifty years ago but it has a capacity more than three-fold as great. There were 5600 vessels of all types on the lakes in 1874 as compared with 2693 in 1924 but the fleet of the latter year had a tonnage of 2,791,000 as against a tonnage of 842,000 for the fleet of 1874. This increase in the size of ships has been due to the replacement of sail by steam and the development of the bulk carrier, the characteristic type of lake vessel. Steam vessels first outnumbered sailing vessels on the lakes in 1886 and in 1924 only seventy-five specimens of the earlier type remained as compared with 1320 steamers. More than 700 of these steamers exceeded 1000 tons and 313 of them were bulk freighters of 4000 tons and over.[9]

The bulk freighter is what biologists would call a unique example of successful adaptation. Designed to carry ore or coal or grain, its dimensions must conform to the width and depth of the Sault Canal locks. The navigation season is barely eight months long and the bulk freighter therefore must be susceptible of the quickest possible loading and unloading, which in every case is done by machinery. So, a type of vessel has been developed that best meets these requirements. With depth limited by that of canal locks and harbor channels and with beam similarly restricted to the necessities of the locks and of mechanical unloaders, great capacity has been achieved through building vessels of a length which according to maritime standards is out of proportion to depth and to beam. The newer bulk freighter is a craft about 600 feet long, sixty feet beam, and drawing eighteen to twenty-one feet. All engines and coal bunkers are placed far aft. Above them are the engineer officers' and crew's quarters. The deck officers' and crew's quarters and the navigating bridge are far forward. Nearly the whole of the interior of the vessel is a single vast hold, unbroken by any bulkhead from near the bow to near the stern. Into this hold from the empty decks, open many hatches through which the ore or grain or coal is dumped, and unloading machinery lowered.

These vessels can handle a prodigious amount of bulk cargo in a phenomenally brief time. On a whole voyage from down lake port to the upper lakes and return the average time in port does not amount to

[9] *Transportation on the Great Lakes.*

more than about twenty-seven hours. The record for loading and unloading is held by the *D. G. Kerr*. Both records were made on a single voyage in September 1921. She received a cargo of 12,508 gross tons of iron ore at the Duluth and Iron Range Railroad ore dock at Two Harbors, Minnesota, in just sixteen and one-half minutes, and unloaded the same cargo in three hours and five minutes. The same vessel received a cargo of 14,245 tons of bituminous coal in four and a half hours, while the grain loading record is held by the *West Mount*, which on October 31, 1921, took on 355,000 bushels at Port Arthur in five hours. As a result of this celerity of loading and unloading, the seasonal performances of these big freighters are equally astonishing. The moving of more than 300,000 tons of freight in a season of eight months is not unusual; performances in excess of 400,000 tons are frequent, while the record is that of the *William K. Field* which in the year 1924 carried 552,014 tons of ore and coal.

Another type of vessel which although not peculiar to the Great Lakes has been developed there to peculiar perfection, is the car ferry. These big craft, built of steel, from 250 to 340 feet long and from forty to sixty-four feet in beam, can load from twenty to thirty freight cars and nearly as many automobiles besides. They also carry passengers. There were in 1924 twenty-eight such vessels operating on thirteen ferry lines on the lakes and connecting channels. The service on Lake Michigan is the most extensive, thirteen vessels operating on three lines between important points on the eastern and western shores of the lake. The Lake Michigan car ferry traffic is sixty per cent of that of the total for all the lakes. Next in importance is that on Lake Erie between Ohio and Canadian points, while important ferries are also run across Lake Ontario, the St. Mary's River, and the Straits of Mackinac, the Detroit and St. Clair Rivers and the St. Lawrence. These powerful vessels can operate safely before and after the usual season of navigation and on Lake Michigan keep in service the entire winter except on the line across Green Bay to Menominee. In 1923 they carried a little more than 8,000,000 tons of freight. Coal was the most important commodity, especially on the lines to Canada, but miscellaneous package freight furnished a large proportion of all traffic. Manufactured iron and steel was also a significant item.

The third great classification of lake commerce is that of package freight. There were 70 vessels larger than 1000 tons engaged in this trade in 1923 and they carried 3,000,000 tons or about 2.3 per cent of all

the commerce on the lakes. Eighty per cent of it was shipped from the ports of Duluth-Superior, Chicago, Milwaukee, Buffalo, Alpena, and Cleveland, in the order given; and ninety per cent of the receipts were handled by the same ports with the exception that Erie replaced Alpena and that Buffalo was the leading port, followed by Chicago, Milwaukee, Duluth-Superior, Detroit, Cleveland, and Erie. The remaining ten to fifteen per cent of this traffic was divided among about 100 other ports on the lakes. This miscellaneous traffic on the lakes has declined steadily during the past twenty years. In 1906 the tonnage was 7,000,000; in 1916, 5,500,000; in 1923, 3,000,000. The proportion of the traffic to the total lake commerce has also fallen from 9.4 per cent in 1906 to 2.3 per cent in 1924. The greatest single reason for this is probably the interpretation by the Interstate Commerce Commission of the Panama Canal Act which forbade competing railroads to own or operate steamer lines. As a result of this ruling the railroads disposed of their packet lines in 1917 and since the railways in most cases continued to own the terminals private capital has been chary of trying to compete on the water.

Finally, the Great Lakes carry a considerable passenger traffic, most of it on Lakes Erie and Michigan. About half of the package freight carriers also carry passengers and the demands of travel between the great cities of Buffalo, Cleveland, and Detroit have developed a type of overnight passenger vessel which for size, speed, and luxury is the equal of any similar craft on any waterway. There were more than 6,500,000 passenger arrivals and departures on the lakes in 1923 with many important ports such as Detroit unaccounted for. Of the ports of which record was kept, Buffalo was the leader, its passenger traffic amounting to 2,700,000. Chicago was next with 1,200,000 and Cleveland third with close to 500,000. The largest two passenger vessels on the lakes are the *Greater Detroit* and *Greater Buffalo* of the Detroit and Cleveland Navigation Company. They operate between Buffalo and Detroit, are 550 feet long, have a speed of twenty-one miles an hour, and have accommodations for 1200 passengers. These vessels are side-wheelers and are unique in being fitted with bow as well as stern rudders, permitting quick turns in narrow channels. They are the largest vessels in the world so equipped. In addition to this overnight passenger travel between the larger lake ports there is in midsummer a considerable tourist traffic on all the lakes, through steamers operating from Buffalo and Port Huron to Duluth, Port Arthur, and Chicago.

It needs only this brief review to show that these lakes, which really

are of the size of inland seas, bear a commerce unequalled in importance by any other inland waters in the world. But the waters which bear this commerce possess one advantage which it lacks. The water of Lake Superior and all its mighty sisters flows freely to the sea; the commerce they bear is barred from the oceans by the Niagara barrier and by a few miles of shallow broken water along the St. Lawrence. The people who dwell around the lakes have built an inland empire by the use of them for commerce, an empire denied the access to that common carrier of the nations which every vital, growing land must have. The grain of this empire goes to all the world, and all the world sends to it the raw materials and luxuries it demands; but each must pay toll to enter or to leave this almost perfect system of inland navigation. To reduce this toll to a minimum by reducing to a minimum the natural obstacles which stand between the commerce of the lakes and the ocean is one of the greatest of our national tasks and one fraught with immeasurable significance to all the world.

CHAPTER VII

The St. Lawrence Waterway

The voyager down the St. Lawrence, entering the river at the outlet of Lake Ontario, hardly needs to be told that he is on one of the greatest waterways of the world. The width of the stream, its clear water, its even flow, all tell of a volume and depth commensurate with the outlet of the Great Lakes, of a river whose further journey to the sea is likely to lead it by great cities, through populous valleys, and upon whose waters the commerce of a continent might pass. All this might be true were it not that Lake Ontario lies 246 feet above the sea and that the waters of the St. Lawrence in the distance of 183 miles between the lake and the harbor of Montreal must fall all but some twenty feet of this altitude, a fall more than sixty feet in excess of that at the cataract of Niagara. Water will not run up hill, neither will commerce; to bring the trade of the oceans into the lakes some way must be found of lifting the ships up this slope. This is partly accomplished today but most imperfectly. To complete the task, to make in effect a sea coast of the shores of the lakes is the aim toward which all improvement of the St. Lawrence Channel is ultimately directed.

For some sixty-eight miles after leaving Lake Ontario, the waters of the St. Lawrence continue their placid and even flow. Everywhere in the channel except for twelve narrow reefs, there is enough water to float the greatest ships. But when the river reaches Prescott, Ontario, and Ogdensburg, New York, its character changes. Here it begins its irregular descent from the level of the lower lake plain to the level of the sea, a descent which from some 114 miles gives a succession of rapids and swift water, interspersed with stretches of quiet flow. In two places the river widens out into lakes. The actual length of all the rapids is about forty miles, the total length of the present canals which carry traffic around them is forty-six miles. There are six of these canals, all on the Canadian side of the river.

Three miles below Ogdensburg, at Chimney Point, the first broken water occurs. This is known as Galop Rapids and around it has been constructed the Galops Canal, $7\frac{1}{2}$ miles long, with three locks taking care of a difference in level of $15\frac{1}{2}$ feet. From the lower end of the canal

there is a stretch of 4½ miles of navigable water in the river to the Rapide Plat in which the river descends 11½ feet in a little less than four miles. The Rapide Plat Canal with two locks and a total lift of 11½ feet carries the river traffic past them and into another reach of 9½ miles to the entrance of the Farrans Point Canal around the rapids of the same name. This is the shortest of all the canals, only a mile and a half long and with but one lock with a lift of 3½ feet. Another stretch of five miles of smooth water leads to Dickinson's Landing where the eleven-mile long Cornwall Canal begins. This canal leads around the famous Long Sault Rapids in which the river falls forty-eight feet. The canal has one guard and six lift locks and ends at Cornwall where the river widens out into Lake St. Francis, thirty-one miles long and from three to five miles wide. The St. Lawrence here ceases to be an international stream and flows wholly in Canada. At the outlet of Lake St. Francis, the river narrows to a width of about a mile and its waters enter upon the greatest and steepest descent of their course. In a distance of about thirteen miles the river passes through Couteau Rapids, Cedar Rapids, and Cascades Rapids, opening out at their foot into its second widewater, Lake St. Louis, some sixteen miles long and in places eight miles wide. In these three rapids the river falls eighty-four feet and the fourteen-mile Soulanges Canal which parallels them has four lift locks and one guard lock. This is the longest of the St. Lawrence Canals and the one surmounting the greatest and steepest slope of the stream. From its lower end navigation across Lake St. Louis is simple and then comes the final canal of the series, La Chine, around the famous rapids of that name, overcoming an elevation of forty-five feet by five locks in a distance of 8½ miles, and ending in the harbor of Montreal.

It will be seen that the total lift of the twenty-one locks of the six canals amounts to 207½ feet. This, deducted from the level of 246 feet above the sea for Lake Ontario, gives an altitude above sea-level of 38½ feet as compared with an elevation of about twenty feet above sea-level at Montreal. This difference is accounted for by the fall of the river through its quiet reaches amounting in all to about sixty-six miles. The locks are nearly all of uniform size; 270 feet long, forty-five feet wide, fourteen feet deep. New locks on the Farrans Point and Galops Canals are 800 feet long but it is obvious that this increased length merely permits more vessels being locked through at one time and has no effect on their maximum practicable size.

The navigation of the St. Lawrence above Montreal is thus seen to be

limited to craft not more than 260 feet in length, forty-three feet in breadth, and drawing not much more than thirteen feet, which gives a minimum clearance of six inches over the sills of the locks. These dimensions are at once seen to be much smaller than those of the modern lake freighter or of the average ocean cargo steamer so that the lake steamers can not go to sea nor any but the smallest sea-going vessels enter the lakes.

The whole purpose of the proposed St. Lawrence waterway is to break down this barrier and to provide a channel at least twenty-five feet deep and locks at least 800 feet long and eighty feet wide past the rapids. Since the new Welland Canal will have a least depth of twenty-seven feet and there is now thirty feet depth at all points of the channel from Montreal to the sea, it is evident that such a piece of engineering would, theoretically at least, open the Great Lakes to the commerce of the seas. Incidentally a huge amount of water power might be generated as a by-product of the navigation improvements, the total theoretically available being estimated at 5,000,000 horsepower. How this is to be done, how much it will cost, how much it is likely to benefit the United States and Canada are questions which have been exhaustively considered by several international commissions and boards whose findings we shall review as briefly as is consistent with an understanding of the problem.

It is not intended however to review the history of all improvements of the St. Lawrence navigation which may have been said to have begun in 1783 with the construction of shallow canals between Lake St. Louis and Lake St. Francis. Delayed by poverty and war, further improvement waited until 1815, and from then on one improvement followed another until in 1875 the Dominion Parliament ordered the changes in existing works which resulted in what is the present system of canals and locks. The Welland Canal was finished to its present depth, identical with that of the St. Lawrence Canals, in 1887, and for the past forty years such limited navigation as each affords has permitted small vessels to go from tidewater to the lakes.

The deepening of lake harbors and the enlargement of the St. Mary's Canal between Lakes Huron and Superior, followed by the increase in ths size of the lake freighters and the prospective deepening of the Welland Canal, all led to active consideration of deeper St. Lawrence channels during the first decade of the present century. About the same time a series of smaller problems involving boundary waters came into

view, as well as the weighty one of the use of the water power at Niagara. To deal with all these, the International Joint Commission was created by a treaty between the United States and Canada signed in 1909. The question of the St. Lawrence waterway was not acutely active before the war, but afterwards with the memory of freight congestion during the war years and with the Panama Canal disrupting the traffic rate structure of a continent to the disadvantage of the interior states and provinces, the whole question came prominently to the front as a means for the relief of the agricultural midland regions and as a source of electric power.

It was referred to the International Joint Commission in 1920 by the governments of both the United States and Canada and in the following year the commission made its first report, favoring the whole enterprise. Supplementary reports were published. The whole matter still hanging fire and meeting with active opposition from various interests in the northeastern states and in lower Canada, both countries in the spring of 1924 appointed advisory committees of nine members, the one on this side of the border being known as the United States St. Lawrence Commission and being headed by the Hon. Herbert Hoover, then Secretary of Commerce. A joint international board of engineers, three from each country, was also appointed to reconsider the whole problem. As a result of their findings, the United States St. Lawrence Commission made its report December 26, 1926, re-affirming the main conclusions of the earlier report but with a few important alterations. Both bodies are on record as declaring the construction of a St. Lawrence channel from twenty-five to thirty feet deep from Lake Ontario to Montreal to be practicable from the engineering view-point, and economically sound and desirable. The report of the St. Lawrence Commission is the last word on the engineering problems involved. The political problems are not so easily solved. No improvement of the St. Lawrence River in the sector between Lake Ontario and Cornwall where it forms the boundary between Canada and the United States can be undertaken without the consent of both governments. There is opposition in both countries on political and economic grounds. The great sea-port cities of the Middle Atlantic States object on the ground that the improvement would divert foreign trade from them. Similar objection is voiced in Montreal and Quebec, while on political grounds Canadians object to their sharing of the expense of a project which will chiefly benefit the United States, some of whose citizens are in turn objecting to their country spending heavily on a project, the key to the

sovereignty of which will always be in Canada since the greater part of the St. Lawrence is wholly within the Dominion.

Further to complicate the situation, opponents in the United States of the St. Lawrence waterway have suggested the building of a ship canal across New York State from Lake Ontario to the Hudson, the latter to be sufficiently deepened to permit the passage of vessels of twenty-five-foot draft; and of a canal similar to the new Welland around Niagara but wholly on the American side. Advocates of this so-called All-American canal urge it upon the ground that it would benefit rather than injure the port of New York and that it would be more expedient from a military point of view than a canal through a foreign country and along the boundary. The proposal has been pronounced possible by United States Army Engineers who have however condemned it on economic grounds. Its advocates are confined almost wholly to New York State and while the scheme is impractical and chimerical to a degree it will be further considered in a later chapter.

According to the report of the St. Lawrence Commission, a ship canal down the St. Lawrence from Lake Ontario to Montreal with a depth of twenty-five feet and developing 2,730,000 horsepower from the water-power utilized, may be built for $394,000,000. Deepening the channel two feet so as to accommodate it to the use of vessels drawing twenty-five feet would cost $5,800,000 more.[1] Capitalization of the value of the water power would, according to the report, reduce the net cost by $200,000,000 or more. The cost would be shared by the United States and Canada. The work might be completed in from eight to ten years.

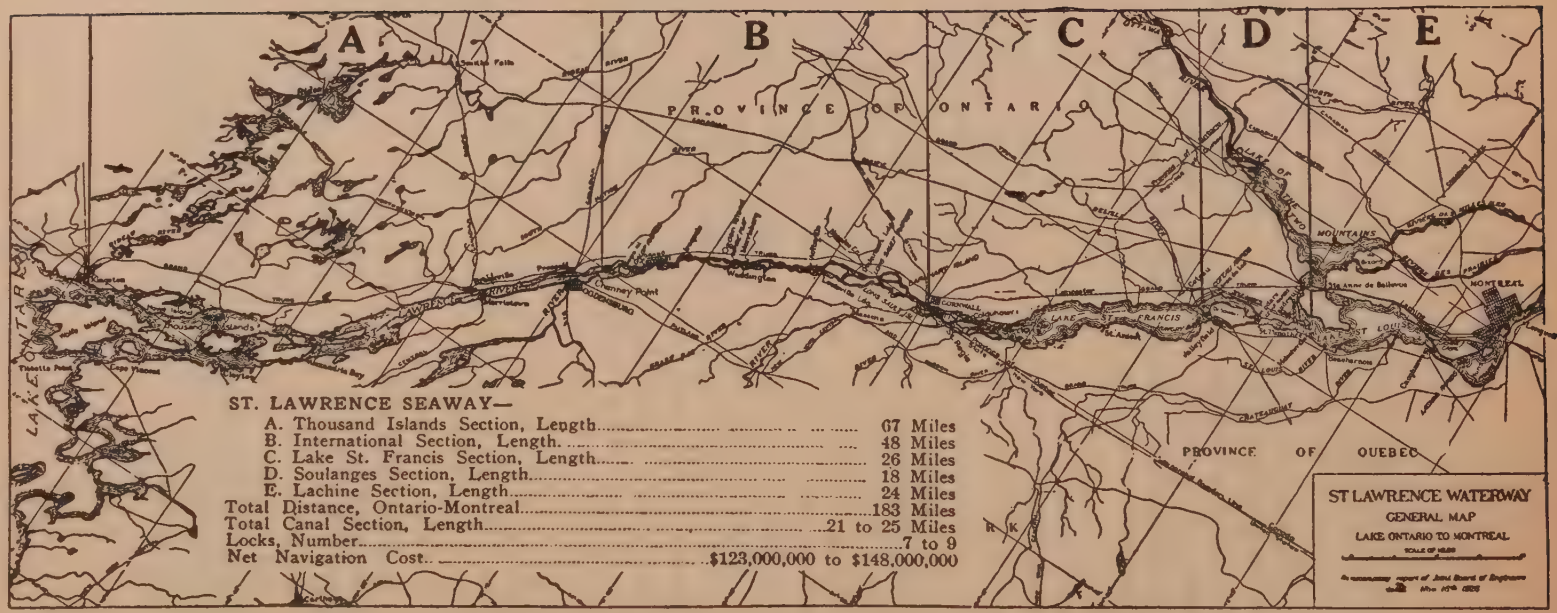
As will be seen later these estimates do not include interest during construction[2] nor such accessory expenses as deepening the harbors of the Lakes to conform to the depth of the ship channel, dredging of Montreal harbor, and the construction of works for the control of the levels of the lakes.[3] They refer only to the actual construction of navigation and power works along the river above Montreal. What is the nature of these works?

Broadly speaking, they consist in the building of one or two dams in

[1] *Hoover Report*, page 47.

[2] Federal engineering estimates seldom if ever do, since the duration of construction depends largely upon the annual appropriations by Congress.

[3] It would however be unfair to charge the St. Lawrence project with all these costs which will eventually be incurred for the benefit of lake navigation.



ST. LAWRENCE SEAWAY—

A. Thousand Islands Section, Length	67 Miles
B. International Section, Length	48 Miles
C. Lake St. Francis Section, Length	26 Miles
D. Soulanges Section, Length	18 Miles
E. Lachine Section, Length	24 Miles
Total Distance, Ontario-Montreal	183 Miles
Total Canal Section, Length	21 to 25 Miles
Locks, Number	7 to 9
Net Navigation Cost	$123,000,000 to $148,000,000

the international rapids section of the river from Ogdensburg to Cornwall, the building of two more dams in the Soulanges section and of one more near the La Chine Rapids, the construction of canals and locks around these dams, the installation of power generating plants at the dams and the deepening and straightening of the channels through the open river and the pools created by the dams. The detailed plans, especially for the development of power, are highly technical and too long to rehearse here. Some are favored by both the United States and Canadian members of the Joint Engineering Board, others by one side or the other. The two principal differences of opinion are in the proper treatment of the international rapids section and in the depth considered most appropriate for the navigation channel. The United States engineers favor the improvement of the International Rapids section by the construction of one dam at or near Barnhart Island at the foot of the Long Sault Rapids with a head of about 85 feet. This would drown out the Galops, Rapide Plat, Farrans Point, and Long Sault Rapids through the formation of a deep pool extending up-stream to Prescott and Ogdensburg and bringing in effect the level of Lake Ontario down to the crest of the dam. The Canadian members of the board favor the handling of the waters of this section of the river in two stages, involving the construction of not only a dam near Barnhart Island but of one near Ogden Island just below Rapide Plat. By this plan the lower dam would have a head of about sixty-seven feet and the upper of about eighteen, varying slightly according to season. The United States engineers favor the one stage development because they say it will afford better navigation through the elimination of one lock, will cost $29,000,000 less, and will afford more power. The Canadians favor the two-stage development because they say that under it the development of power can be carried on in two stages, that the additional power can be fed into the market as the need arises through the initial power development of the upper pool only, so avoiding a glut of power for which there might not be a market for many years. They also point out that under the two stage plan the area of lands flooded by the rise in the river level would be reduced from 22,000 to 12,000 acres. The other main difference of opinion between the United States and Canadian engineers is in the proposed depth of the channel, those from south of the boundary favoring a twenty-five foot depth as nearer to existing channels in the upper lakes, while the Canadians favor twenty-seven feet, the same as provided for in the new Welland Canal.

The Joint Engineering Board is wholly agreed that the power development of the International Rapids section shall precede that of the lower river. It is declared that the 2,730,000 horsepower from the upper rapids would be as much as the market could absorb for some time to come. But it is further agreed by all that provision must be made for the eventual full development of the 5,000,000 horsepower of the river, consistent with the paramount use of the stream for navigation. This would bring the total cost of the project with a twenty-five-foot depth of channel up to at least $620,000,000. As a final alternative it has been estimated that the cost of deepening channels originally twenty-five feet deep to a depth of thirty feet which is to be that over the lock sills of the new Welland Canal, would add $24,400,000 to the cost of the enterprise. As will be seen shortly, the necessity of a thirty-foot channel for the success of the waterway is doubtful. The plans for the waterway as unanimously agreed on by the engineers provide for a navigation route through the 183 miles of river and lake from Lake Ontario to Montreal which shall comprise not more than twenty-five miles of restricted canal navigation and not more than nine locks and shall have at least twenty-five feet depth of channel. This contrasts strongly with the present navigation, fourteen feet deep, forty-six miles through canals, and with twenty-one lift locks. What would be the effect of the construction of this new waterway?

There mathematics ceases and controversy begins. Fervid advocates declare that it would open the Great Lakes to the ocean commerce of the world and that such lake ports as Duluth, Chicago, Cleveland and Buffalo would immediately become seaports for eight months of the year. Opponents say that ocean steamers would not and could not profitably undertake such a long inland navigation as the 1700 miles[4] between the mouth of the St. Lawrence River and Duluth and that even if they did there would not be enough freight offered to make such a voyage profitable.

There are many persons familiar with ocean shipping who do not believe that sea-going vessels would be able to navigate the St. Lawrence waterway and the waters of the Great Lakes. Ocean ships are built to go to sea; compared with lake vessels of equal tonnage they are wider and deeper. They have less cargo space. They have more engine power. It is asserted that the voyage at reduced speed through the

[4] *Hoover Report*, pages 9 and 10.

river and canal channels, the risk of collision or of grounding, the greater overhead, the greater expense of handling freight, would all combine to make such an inland voyage unprofitable if not dangerous to ship and cargo. Furthermore it is said that unless the channel were deep enough to float ships drawing thirty feet it would not attract the ocean freighters.

During the year 1922 there were 1770 vessels entering or leaving New York harbor from the open sea. These vessels made a total of 8526 trips. Of these, 70.7 per cent were made by ships drawing less than twenty-five feet, and 93.8 per cent by those drawing less than thirty feet.[5] According to the United States Department of Commerce, there were on January 1, 1925, some 808 cargo vessels registered under the American flag, excluding combination passenger-cargo vessels and oil tankers. Of these considered, twenty-five per cent drew twenty-three feet or less, sixty-six per cent drew twenty-five feet or less, and ninety per cent drew twenty-eight feet or less. The total tonnage capacity of these several classes does not however run parallel to their relative numbers; for example, all the boats under twenty-three feet draft can carry only 12.79 per cent of the total tonnage of the fleet of which they form one-fourth the total number, while those drawing twenty-five feet, although numbering two out of every three of the merchant fleet with the exceptions noted, have but fifty-four per cent of the total cargo capacity.[6] Panama Canal traffic is typical of ocean commerce. All types of vessels pass and a study of the proportions of those of different drafts gives a close idea of the proportions in the combined merchant fleets of the world. There were 2813 vessels traversing the canal in 1920, of which 71.5 per cent drew less than twenty-five feet and 98.8 per cent less than thirty feet. Those drawing twenty-three feet or less, however formed but 52.8 per cent of the total.[7] In 1925, the proportion of twenty-five-foot vessels was 63.9 and of those drawing less than thirty feet, 94.7 per cent.[8] Testifying before the International Joint Commission, Major-General Black, former Chief of Engineers of the United States Army, declared that of the 14,513 steamships listed in Lloyd's register of world shipping in 1918–1919, those of twenty-five feet draft or

[5] Ritter, *Transportation Economics of Great Lakes-St. Lawrence Ship Channel*, page 33.

[6] *Great Lakes to Ocean Waterways*, page 79 et seq.

[7] Ritter, page 30.

[8] *Commercial Statistics of the United States*, 1925, page 41 et seq.

less comprised 81.45 per cent, while 99.3 per cent drew thirty feet or less.[9] The tendency toward deeper drafts is apparent but is due chiefly to larger tank and ore vessels.

Interpreting these figures it may be stated that more than two-thirds of all ocean steamships draw less than twenty-five feet in salt water, while the number drawing more than thirty feet is insignificant. Vessels of the deeper drafts are nearly all great passenger liners which are not expected in any event to use the St. Lawrence waterway. There is another class of deep draft ship, however, the oil tanker. Most of the modern vessels of this class draw more than twenty-five feet.

But these figures do not mean that two-thirds or more of the world's merchant shipping would be able to use a twenty-five-foot St. Lawrence Channel. There is an important physical fact to be considered that has a great bearing on the question. Salt water is heavier than fresh water and consequently has greater buoyance. If a ship which is loaded to a given depth in salt water is moved into fresh water it will sink from three to seven inches deeper, the higher figure coming close to the increased draft in fresh water of cargo ships of twenty to twenty-five feet draft and of average tonnage for that draft. Since all vessels navigating restricted channels need a clearance of approximately eighteen inches, it follows that if the St. Lawrence waterway had a depth of twenty-five feet it could not be used by ships which were loaded in salt water to a depth exceeding twenty-three feet, which, according to the figures given above for Panama Canal traffic, would exclude nearly half the deep-sea shipping of the world.[10] An increase of the depth of the channel to twenty-seven feet would, however, admit two-thirds or more of the world's shipping, while a depth of thirty feet would admit practically all save the big liners and tankers. The present channel to Montreal whose foreign water-borne commerce is second only to New York in volume among all North Atlantic cities, has a least depth of thirty feet. The new Welland Canal will have a depth of thirty feet over the lock sills, permitting a deepening of the channel to that extent with relatively small expense, and, irrespective of what depth is decided on for the waterway, the engineers recommending the St. Lawrence improvement are all in favor of a similar procedure there. The Canadian

[9] *St. Lawrence Waterway Report, International Joint Commission*, page 62.

[10] This handicap would however be largely offset by the lightening of westbound ships from fuel consumption at sea, and by the discharge or loading of a small proportion of cargo at Quebec or Montreal.

engineers favor an initial depth in the channel of twenty-seven feet, which as we have seen would admit two-thirds or more of all cargo ships.

It seems evident enough that a channel depth of twenty-five feet would admit half of the world cargo tonnage and a depth of thirty feet practically all of it. But assuming the possibility of getting boats through the waterway, would ship-owners try it? That depends on whether they considered it safe and profitable. On the side of safety there seems little doubt. Cargo ships of all the world come 350 miles up the St. Lawrence to Montreal through a river channel with many turns, 110 miles up a narrower and more uncertain channel from the mouth of the Mississippi to New Orleans, the second North American Atlantic and Gulf port, approximately the same distance up the Columbia and Willamette Rivers to Portland, while regular steamer service is maintained from New York to Manaos, 925 miles up the Amazon. But, it is objected, river navigation through open channels is one thing and canal navigation is another. This is perfectly true but it is also true that canal navigation is no deterrent to ocean traffic, provided the canal be deep enough. The Panama Canal is certainly a success from a navigation standpoint yet it is approximately twenty miles longer than the estimated twenty-five miles of restricted navigation through the proposed St. Lawrence canals and it has six locks, or within two, or three at the most, of these proposed for the St. Lawrence. The Suez Canal is without locks but it is the longest ship canal in the world, 104 miles, and it carries a volume of commerce approximating that of the Panama. The Manchester ship channel is fifty-four miles long from the Mersey bar through that estuary and some thirty-five miles of canal construction. It has five locks, a depth of twenty-eight feet, yet although upstream from Liverpool, one of the great ports of the world, it carries an annual commerce equal to that of the foreign commerce of any of our Atlantic cities except New York.[11] In view of these facts it does not seem that the St. Lawrence waterway would be a bar to ocean commerce. Adding to the restricted channel of the St. Lawrence those of the Welland Canal, of the Detroit, St. Clair and St. Mary's Rivers, the sum of restricted navigation from Montreal to Duluth would amount to 150 miles. Of this about fifty miles would be through the St. Lawrence, Welland, and St. Mary's Canals; the remaining distance would be through narrow river channels.[12] This navigation would lead to a coast line of 8300

[11] Ritter, page 20.

[12] *Great Lakes to Ocean Waterways*, page 66.

miles, tributary to which lives nearly half the population of the United States and Canada, a region much larger in area than any country of western Europe and comparable in population to Great Britain, Germany or France.

The trade of this vast inland empire would seem to be a strong bait for the trading vessels of the seas but it is asserted that although ocean vessels might safely enter the lakes it would not pay them to make the voyage because of the length of time required to traverse restricted channels during which the overhead expenses of the ship would continue as usual, because the shallowness of lake ports would prevent their use, because the navigation season would be limited by climatic conditions to about seven months, because the freight traffic would be largely one way, and because additional insurance charges would be a burden on profits.

Some of these objections have weight. Ocean vessels cost more to build and to maintain than do lake steamers which could bring freight from the Lakes to Montreal cheaper than any sea-going vessel could but against this would be the expensive transfer at Montreal. Lake ports would have to be deepened to correspond to the depths of the St. Lawrence Channel. When it is considered that the deepening of the present connecting channels alone would cost from $44,000,000 to $86,000,000 depending on whether a twenty-five-foot or thirty-foot depth was attained, it will be seen that the corresponding deepening of even the larger lake ports would be a costly job. Insurance charges are greater for ships using the St. Lawrence route and might be expected to be still higher for those entering the lakes.

On the other hand the objection that the navigation season would be only seven months long is of little weight. Montreal foreign commerce has the same handicap yet it is exceeded only by that of New York. The Baltic Sea carries a very great commerce to eastern Germany, Sweden, Poland, and Russia, yet it is closed by ice during the winter. The present St. Lawrence Canals, inadequate as they are, carry a commerce of close to 6,000,000 tons annually.[13]

The question of one-way traffic, of the impracticability of using cargo ships for package freight, of congestion during the grain exporting season, all are part of the general problem of the extent and nature of the traffic to be expected to use a St. Lawrence waterway. This has been the subject of extended studies by the Department of Commerce and such

[13] 7,900,000 tons in 1927.

semi-official bodies as the Great Lakes-St. Lawrence Tidewater Association. The latest published figures of the Department of Commerce estimate this annual prospective traffic at from 18,600,000 to 23,600,000 long tons, of which approximately 8,000,000 to 12,000,000 tons represent exports; 3,000,000 to 4,000,000 tons imports; and the remainder coastwise or intercoastal traffic.[14] The grand total is three to four times that of the present St. Lawrence Canal traffic, about twice that of the port of Montreal, and about two-thirds of the total foreign commerce of the port of New York and connecting channels. Where is this volume of freight coming from and of what is it to consist?

The source of the traffic is expected to be the vast region bounded roughly by a line drawn from Buffalo to St. Louis and thence to eastern Montana and by a corresponding tributary area on the Canadian side of the border. Of the export traffic by far the leading items are expected to be grain and flour, meat products, starch and glucose, linseed cake and meal. The remainder of the prospective export trade is divided among the large number of manufactured articles made in the tributary district, the principal item of which is iron and steel. Iron ore is credited with a million tons, this however, for domestic consumption.[15]

Prospective imports are smaller in volume and divided among a greater number of items. Sugar is expected to furnish nearly one-fourth of the total tonnage.[16] Bananas and other tropical fruits are expected to move up the waterway in large volume, as are coffee, tea, vegetable oils, and rubber; while more than a tenth of the tonnage is expected from such raw materials of the steel industry as manganese, ferro-manganese, pyrites and magnesite. Miscellaneous freight, taken at rates which, because the vessels would otherwise go empty into the lakes, are expected to be low enough to compete with freight liners, is counted on for the greater part of the balance. In this connection it is interesting to compare the predicted import traffic on the St. Lawrence with that actually carried on the Mississippi where in 1925 one-third of the upbound tonnage above Vicksburg was aluminum ore, and one-fifth sugar or allied substances.

Assuming that these forecasts for the St. Lawrence are approximately correct, what will be the saving in freight bills to the midland farmer and manufacturer who ships down the St. Lawrence or receives his raw

[14] *Great Lakes to Ocean Waterways.*
[15] Ritter, page 123.
[16] Ritter, page 123.

materials from the same waterway. No definite estimate has been made by the Department of Commerce as to aggregate savings, but on the basis of operating, maintenance and fixed costs of ocean vessels navigating a restricted waterway, it is calculated that a rate on wheat from Duluth or Chicago to Liverpool of from 8 to 11.2 cents a bushel would be profitable to ships. This compares with the cheapest present rate between these points of 17.6 cents.[17] This saving would be passed on to the farmer nearly intact and would mean an increase in the price of his wheat of 6 to 8 cents a bushel, which on a quarter section farm in a year of average yield would mean an added income of $100 to $150. This would be on wheat alone. It is estimated and the estimate is quoted without criticism by Secretary Hoover in his report as chairman of the St. Lawrence Commission, that "the values in a single year to the farmers alone would equal the capital cost of the waterway."[18] The savings would not be merely on the tonnage transported but on all potential traffic, the price of which to the producer would be raised accordingly.

It may be asked by the reader, how long would a voyage from Duluth or Chicago to a north European port such as Liverpool require. This has been calculated by the Department of Commerce at sixteen days and twenty-one hours for a vessel making twelve statute miles per hour in open water, an average rate for a cargo vessel. The distance from Duluth to Liverpool by the St. Lawrence waterway is 4544 miles, of which all but 173 is open navigation, 1088 miles on the lakes, 1097 on the St. Lawrence, and 2186 on the ocean. Fifty miles of the restricted navigation would be through canals, having in all seventeen locks.[19] A speed of five miles an hour is estimated for the passage of the open reaches of the canals, and one hour is allowed for the passage of each lock, making a total of twenty-seven hours for the traversing of the canals. The remaining 123 miles of restricted navigation is along the St. Mary's, St. Clair, Detroit, and St. Lawrence Rivers, twenty-three miles being below Montreal. Along these channels a speed of nine miles an hour is predicated. Based on this schedule, the passage from Duluth to Montreal would require five days and nine hours.

Such is the outline of the proposed St. Lawrence waterway. Some of the statements made are highly controversial, others are unquestioned.

[17] *Great Lakes to Ocean Waterways.*

[18] *Hoover Report*, page 2.

[19] After completion of new Welland.

Summarizing them all and illuminating them as far as possible with the light of reason, it seems that a twenty-five-foot channel from Montreal to Duluth could be had for the expenditure of about $400,000,000 in addition to the cost of the new Welland Canal, that a thirty-foot channel would cost about $40,000,000 more, exclusive of the deepening of lake harbors; that such improvement of the St. Lawrence would create 2,730,000 horsepower of electrical energy and that this might be increased to 5,000,000 horsepower by the expenditure of $225,000,000 additional.[20]

The present St. Lawrence Canals carry 6,000,000 tons of freight in a season of from seven to eight months.[21] It seems highly probable therefore that a deepening of the channel to twenty-five, or better still to thirty feet, would attract a certain amount of ocean shipping. The navigation would not be more difficult than that of many other river channels and canals. The prospective trade would be huge in volume. With such an inducement it seems probable that ocean freighters would go after it or that a special type of freighter suitable for both lake and ocean navigation might be developed. The present lake freighter is an example of such a vessel designed to fill a special need. It is not suitable for ocean navigation but it fills its purpose admirably.

Against these more optimistic views which might be reinforced with the statement that during the season of 1925, forty-five vessels made voyages up and down the present shallow canals to and from the sea,[22] is the uniformly unsuccessful experience of those who have tried further to develop such a trade. In these days however a sea-way of fourteen feet depth is hardly less than a joke. A canal of twenty-five or thirty feet would be a very different matter. It seems to the author that it should be at least twenty-seven feet and that less than that would mean money thrown away.

A twenty-seven-foot channel, with the deepening of lake ports, would in great part open the lakes to the ocean commerce of the world. It would cost approximately $500,000,000, but, if used to capacity, it would greatly ameliorate the economic condition of the midland states and of western Canada and result in an increase in wealth, more than sufficient in the opinion of many, to pay in a few years for the whole enterprise. The cost moreover would be shared with Canada in some proportion and water power would be a big off-set. Mr. Hoover estimates the net cost

[20] *Hoover Report*, pages 47–49.
[21] 7,900,000 tons in 1927.
[22] Ritter, pages 249–250.

of a twenty-five-foot channel to the joint governments at $123,000,000 to $148,000,000. This however includes nothing above the St. Lawrence.

But to insure a twenty-seven-foot channel, or even a twenty-five-foot one, another important requirement must be met. The reservoir of the lakes must be kept at a fairly constant level. The water must be conserved; diversions which would lower its level must be watched and if possible prevented. If it is not possible to prevent them their effects must be compensated for. How to do this is a problem whose solution is less expensive than any other feature of the St. Lawrence enterprise, in the cost of which it has been included, but it is one of first class importance.

CHAPTER VIII

Great Lakes Levels

The Great Lakes, as a unified system, are in effect an immense reservoir, of which the St. Lawrence river is the natural spillway. The five principal lakes are on four different levels. The maintenance of these levels depends upon three factors, the amount of discharge into that level from the one above, the amount of discharge to the one below, and the net rainfall.[1] Taking all the lakes together, their mean levels depend finally upon rainfall and run off down the St. Lawrence or through other natural diversions or through artificial ones. Taking each lake by itself, its level depends on the proportion between the amount of water running into it and that running out of it.

Probably many readers are familiar with an old problem in arithmetic which plagued them in their school days. They were asked to consider a hypothetical tank or reservoir of given capacity which has outlets and inlets of different rates of flow and to determine how long it would take the tank to run dry or to spill over. The problem of lake levels is quite similar to this school-day teaser. We are given a body of water of known capacity. It has certain sources of supply; it has certain outlets of known rate of flow. The problem of the engineers interested in maintaining the level of the lakes is to strike a balance between these factors. The source of supply of the water of the lakes as a system is rainfall, an uncontrollable factor. The problem then comes down to regulating the outflow of all the lakes or of some particular one whose level is to be maintained at a predetermined height.

Let us look at the problem in its simplest form. Imagine a small pond, fed by springs of a uniform and constant flow, and drained by a single outlet. Evidently the system is in equilibrium. The rate of inflow and outflow balance. Suppose now that we place some obstruction in the current of the outlet. It will slow up the rate of flow and since the volume of flow depends on the velocity and cross-section of the outlet, the volume of the outflow will be diminished. As a result the

[1] Net rainfall is total precipitation less evaporation. It includes melted snow measured as rain.

level of the pond will rise. This will go on until the increased head due to the raising of the level causes an increased velocity of the stream which with its increased cross-section due to increased depth causes in turn an increased outflow that prevents further rise of the pond. The effect of the obstruction will be a rise of the level of the pond and we must be careful to note that this effect results from any obstruction of the flow of the stream and not necessarily from a dam, whose effects in raising the level both of the stream and of the pond would be obvious.[2]

Suppose now on the contrary that we deepen or widen the outlet. The head at first remaining the same, the velocity of the stream will likewise remain the same and as the cross-section has been increased the volume of flow will be made greater. This will lower the level of the pond until the diminished head brings down the volume of the outlet to a point at which equilibrium is again reached.

There is the outline of the problem of maintaining the levels of the Great Lakes at points desirable for commerce. We cannot control the rainfall but we can control the delivery of water from one lake level to the next below it and we can control the outlets of the whole system. There are two of these, one natural, the other artificial. The natural one is the St. Lawrence River, which however affects only the level of Lake Ontario. For the lakes above Niagara, the Niagara River is the natural outlet. The artificial outlet is the Chicago Drainage Canal. So far as the lakes above Niagara are concerned, the factors which may be controlled so as to affect their levels are the St. Mary's River, affecting principally Lake Superior, the channels through the Detroit and St. Clair Rivers and Lake St. Clair which affect the level of Lakes Michigan and Huron, the natural and artificial channels over the Niagara escarpment, which affect all the lakes above that point, except Lake Superior, and the Chicago Canal which affects all the lakes below Superior because the water so withdrawn is never again returned to the Lake system but flows to the sea through the Mississippi River.

Left to themselves as a natural drainage system and without artificial diversions or alterations of their connecting and drainage channels, the Great Lakes would reach an equilibrium of levels affected only by the excess of rainfall over the evaporation of their drainage basins. Such was the case before the first artificial diversion, that due to the construction of the Welland Canal, which took for its operation a certain amount of water from Lake Erie and so lowered that lake and all the others above

[2] Warren Report, page 353.

to a slight though calculable extent. From that time on a series of artificial diversions have contributed to the lowering of the levels above Niagara, another series of obstructions to the channels have acted to raise the levels, the rainfall has been a very variable factor, and as a result the upper lakes have shown a general diminution of level in recent years although by the end of 1925 a change had begun in the opposite direction. This lowering of levels has been a great burden upon shipping interests who have been unable to load their ships to capacity because of the lessened depths in the channels and harbors and they have sought to find the cause and the remedy. About both and especially about the former has raged one of the greatest controversies in our legal history. Whether Chicago or the climate is to blame is a problem which after years of stormy litigation has been left for the Supreme Court and Congress to decide.

But the Chicago diversion, of which more later, is not the principal artificial factor affecting lake levels. It withdraws 8500 cubic feet of water per second from Lake Michigan. This unit, cubic foot per second, which is the one commonly used for the measurement of stream flow, will be frequently met with in this chapter and will be abbreviated as c.f.s. The other artificial diversions or interferences with the natural channels which have material effect upon lake levels are as follows.

Regulating works on the St. Mary's River at the outlet of Lake Superior to correct for the diversion of water for power at the Soo.

Diversions from Lake Erie for power and navigation through the Welland Canal and from the Niagara River above the rapids.

Changes in the discharge capacity of the St. Clair River at the outlet of Lake Huron, affecting principally the level of Lakes Michigan and Huron, and changes in the discharge capacity of the St. Lawrence affecting only Lake Ontario.

The principal effect of these changes of flow is upon the levels of Lakes Michigan, Huron, and Erie. The effect of the regulating gates at the outlet of Lake Superior is almost wholly on that lake whose low levels have been somewhat raised and high levels somewhat lowered since their installation under the control of the International Joint Commission in 1914. During the next eight years, water was impounded in Lake Superior and the levels of the lower lakes reduced by three or four inches. From 1923 to 1925 this excess water was released with the result that by 1926 the level of the lower lakes was higher than it would otherwise have been. These statements are substantially quoted from the report of the St. Lawrence Commission submitted by Herbert Hoover.

The original outlet of Lake Huron into the St. Clair River was obstructed with numerous shoals. These were dredged to form a channel twenty-one feet deep and 2400 feet wide, increasing the discharge capacity of the lake. This in turn resulted in the scouring out of the original channel by the current to a depth of forty feet with a total lowering effect on the level of Lakes Huron and Michigan estimated at the present time at about seven inches. Dredging of the Detroit River has had no material effect upon levels because the excavated material was piled in such a way as to narrow the channel, thus keeping its cross-section approximately constant.

The present Welland Canal takes 3100 c.f.s. from Lake Erie, lowering its level about 2 inches and that of the upper lakes by an almost inappreciable extent. The diversions of approximately 50,000 c.f.s. from the Niagara River for power purposes are estimated to be without appreciable effect upon lake levels because the greater part of this water is taken from the river below the first rapids and consequently has little more effect than if taken out below the falls. Diversions from the upper reaches of the river have been largely compensated by the narrowing of the stream by intake structures and by bridge and pier construction across and along the stream.

At the head of Galops Rapids on the St. Lawrence, a dam, known as Gut Dam, has been built across a by-channel between an island and the Canadian shore. This obstruction to the discharge of the river has raised Lake Ontario and the river above the obstruction nearly five inches. It is of course without effect upon the upper lakes.

All these artificial changes in the flow of the water down the lakes do not alter the total quantity going down the St. Lawrence, nor affect the level of that stream. The Chicago diversion is in an entirely different class. Although no more effective in lowering lake levels than some of the preceding modifications of the discharge of the lakes are upon some of them, it is unique in that it affects the levels of the whole lake and river system from the outlet of St. Mary's River into Lake Huron to where the St. Lawrence meets the ocean tides below Montreal. It has had an eventful and surprising history and faces a contentious future.

Early explorers noted that the upper reaches of the Chicago River were separated by an almost imperceptible and marshy divide from the headwaters of the Desplaines River which flows into the Illinois. When the boom in canal building was at its height, a canal was constructed connecting the two watersheds. Known as the Illinois-Michigan Canal,

it was opened in 1848, creating a diversion of not more than a few hundred cubic feet per second pumped from the waters of Lake Michigan. It fell into disuse toward the end of the nineteenth century, being entirely superseded between Chicago and Joliet by the Drainage Canal. But its existence gave the clue to a solution of what forty years and more ago was one of the greatest problems in municipal sanitation in America.

When, in 1840, Chicago was becoming a rather large town with a population approaching 5000, wells were superseded as a water supply by the water of the lake. There were no sewers then nor for a number of years after so that this source of supply was reasonably pure. The first sewers were built in 1856 and according to the practice then and for many years after in use not only in Chicago, but in most cities they were built to drain into the nearest body of water, which in this case happened to be the Chicago River and the lake. Thirty years later the city had a population of 681,000 and an exceptionally high typhoid death rate. It was felt that something must be done, and, as a result of the discussion of many plans, the Chicago Sanitary District was organized and the drainage canal planned. The essential part of this project was the deepening of the Chicago River and the dredging of a canal from it to the Des Plaines River which flows into the Illinois and thence into the Mississippi, by this means reversing the flow of the Chicago River. All the city sewage was to be emptied into that stream, which, augmented by the waters of Lake Michigan, was to dilute it and carry it away from the city and the city's source of water to the distant waters of the Illinois and the Mississippi where it was to be purified by natural agencies and further dilution. The project was begun in 1892 and the first water from Lake Michigan flowed "up" the Chicago River and into the distant Mississippi on January 2, 1900. Construction costs were met by bonds issued by the Chicago Sanitary District, organized by the state legislature, and comprising the city of Chicago and some adjacent territory. The original plan of the system has been added to from time to time by the building of additional feeder canals and pumping stations. Its total construction cost up to 1923 was estimated by the trustees of the sanitary district as approximately $97,500,000.[3]

As a sanitary measure, the project was, from the viewpoint of Chicago, an unqualified success. The typhoid death rate, which in the five years 1890–94 was 92 per 100,000 per annum, was cut 10 years later, for the

[3] Memorandum on drainage and sewage conditions at Chicago.

years 1900–1904, to a rate of 29.[4] It will be noted however that by far the greater portion of this decrease occurred during the last decade of the nineteenth century and before the drainage canal was in operation and that the decrease was doubtless in large part due to the progressive extension of the water-intake cribs farther out into Lake Michigan and to the general improvement in sanitary knowledge and practice. In the past twenty years the reduction of municipal typhoid death rates in the United States has been one of the major achievements of sanitary science and Chicago's experience is only typical of that of many cities which did not adopt the method of solution of the problem which was applied there. In New York, for example, the typhoid death rate average for the five years ending in 1904 was 17.0 per 100,000 per annum; for the three years ending in 1922 it was 2.3. In Washington the rate dropped during the corresponding period from 63.2 to 6.1, and in Boston from 23.0 to 2.0. The rate of Chicago for the single year 1926 was 0.8 or about one per cent of what it was a generation before.[5] This is certainly an impressive demonstration of the value of modern sanitation but how much of it should be ascribed to the drainage canal is open to question, since when the canal was planned modern methods of purifying water-supply and sewage were, in practice at least, unknown. Such a progressive city as Hamburg had a first-class cholera epidemic in 1892, an episode which any city in the western world would today consider criminal. If all of Chicago's sewage were treated according to modern methods and then dumped into the lake, from which water afterwards purified by most modern methods were taken for potable purposes, it is doubtful if the typhoid rate would rise to any such height as it stood at thirty years ago. It would be a dangerous and inexcusable experiment to try and there is no doubt but that the drainage canal has saved and is saving the lives and contributing to the health and happiness of thousands of the residents of Chicago every year.

But the canal requires water to operate. That water comes from Lake Michigan. It lowers the level of that lake at least six inches; it lowers the level of Lake Huron an equal amount and those of Lakes Erie and Ontario about an inch less;[6] it lowers even the level of the water in Montreal harbor by about four inches.[7] These estimates are for the

[4] Memorandum on drainage and sewage conditions at Chicago.
[5] Memorandum on drainage and sewage conditions at Chicago.
[6] Hoover Report, page 22.
[7] Hoover Report, page 50.

present diversion of 8500 c.f.s., legalized by a permit of the secretary of war terminating December 31, 1929. The actual amount of water used by the canal has varied from about 5000 to more than 12,000 c.f.s., the last figure however only in exceptional cases and for short periods. When the canal was opened the Chicago River had a depth of seventeen feet and it was shown that a flow of more than about 5000 c.f.s. would create a current dangerous to navigation. This withdrawal had been authorized by Secretary of War Alger in 1899. In 1901 Elihu Root, Secretary of War, on these grounds reduced the authorization to 4167 c.f.s. The river was subsequently deepened to twenty-six feet so that a flow of 10,000 c.f.s. would not create a dangerous current. During the same period a power plant, designed to use 10,000 c.f.s. was built at Lockport, Illinois, to utilize the thirty-four-foot head in the canal at this point. This power plant was put in operation in 1907 and has a theoretical capacity of 36,000 horsepower which is used for operating the canal and for sale to the city of Chicago and other municipalities and private interests.[8]

The permits by the secretaries of war had both been subject to any direct action by Congress, which however did not intervene. Meanwhile, in 1906, shipping interests on the lakes called the attention of the federal government to the alleged excessive withdrawal of water, resulting in lower levels of the lakes and a decrease in the possible loading capacity of their ships. The federal government then filed an application in the federal court in Chicago for an injunction restraining the sanitary district from any withdrawal exceeding 4167 c.f.s. It was not however until 1912 that arguments in the case were heard before Judge Kenesaw M. Landis who after eight years delivered an oral opinion to the effect that the withdrawal in excess of 4167 c.f.s. resulted in a lowering of the lakes to "such an extent as to be an interference with navigation;" that the diversion was unlawful and that an injunction should be issued.[9] The reason for the extraordinary delay of eight years in deciding what appeared from the language of the decision to be a simple case is not apparent. Commenting upon it Mr. Justice Holmes of the United States Supreme Court in a decision of that court, January 5, 1925, upholding the government on appeal, stated, "No valid excuse was

[8] Hughes Report is authority for historical data.

[9] *The Great Lakes Issue*, page 18.

offered for the delay. There was a motion for reconsideration but the judge took no further action of any kind until he resigned in 1922."[10]

The case first came before the Supreme Court on an appeal from a decree for an injunction against the sanitary district, entered by Judge Carpenter of the United States District Court at Chicago. The decision of the Supreme Court, written by Mr. Justice Holmes,[11] was based broadly on three grounds. First that under the law of Congress, March 5, 1899, "the creation of any obstruction not affirmatively authorized by Congress to the navigable capacity of any of the waters of the United States is hereby prohibited," and that alteration of channels or structures likely to affect them shall not be made without authorization of the Secretary of War. The Supreme Court found the Chicago Drainage Canal diversion of 8500 c.f.s. to be in effect an unauthorized obstruction to navigation. Application for withdrawal in excess of 4167 c.f.s. had been denied by War Secretaries Taft, Stimson, Garrison, Baker and Weeks. Secondly, the Supreme Court found that the unauthorized withdrawal was in violation of the treaty with Great Britain of 1909 which in the language of the decision, "expressly provides against uses 'affecting the natural level or flow of boundary waters' without the authority of the United States or the Dominion of Canada within their respective jurisdictions and the approval of the International Joint Commission agreed upon therein." The decision further stated that, "it is doubtful at least whether the secretary (of war) was authorized to consider . . . . the sanitary needs of Chicago," and later states that "probably the dangers to which the city of Chicago will be subjected if the decree is carried out are exaggerated."

The decision of the Supreme Court affirmed the decree for an injunction to go into effect within sixty days, "without prejudice to any permit that may be issued by the secretary of war according to law." The secretary of war accordingly called a hearing in Washington in February, 1925, at which representatives of the Sanitary District and of shipping interests were heard. The secretary found as the result of this hearing that by the application of modern methods of sewage disposal it would be possible for the city of Chicago to carry off such treated sewage by the use of not to exceed 8500 c.f.s. He therefore denied the application of Chicago for a diversion of 10,000 c.f.s., but gave a permit for 8500 c.f.s.,

[10] Sanitary District of Chicago vs. United States, 266 U. S. 405, 432.
[11] Sanitary District of Chicago vs. United States, 266 U. S. 405, 432.

expiring December 31, 1929, looking toward further reduction, and contingent upon prompt action by the city and sanitary district of Chicago in installing sewage disposal plants and a metering system in their water supply.[12]

Meanwhile the State of Wisconsin had brought suit in the United States Supreme Court against the Chicago Sanitary District, alleging impairment of the navigation interests of the state and questioning the authority of the secretary of war or even of Congress to so dispose of the gifts of nature for the benefit of a single community. The Supreme Court appointed former Justice Charles Evans Hughes to hear the testimony in this case in which Wisconsin was joined by the States of Minnesota, Michigan, Ohio, Pennsylvania and New York.

Mr. Hughes reported to the Supreme Court in November, 1927, recommending that the complaint of the several lake states against the Sanitary District be dismissed. He found that the diversion of 8500 c.f.s. from Lake Michigan lowered the level of that lake and of Lake Huron by approximately six inches, and the levels of Lake Erie and Lake Ontario by approximately five inches; but that this could be compensated for by engineering works at the outlets of Lake Huron and Lake Erie insofar as they applied to the levels above Niagara. Mr. Hughes also reported that this lowering of the water had resulted in a loss to shipping interests which, while extensive, could not be precisely determined.

On the questions of law involved, Mr. Hughes concluded that Congress had full power to regulate the diversion, subject to the Constitution, either by itself or by delegated authority; that it had not directly authorized the diversion but had conferred authority to do so upon the secretary of war and that such delegated authority had been exercised in conformity with the Constitution. He therefore further concluded that "the permit of March 3, 1925, is valid and effective according to its terms, the entire control of the diversion remaining with Congress" and that neither the State of Illinois nor the Sanitary District "had authority to make or continue the diversion without the consent of the United States." His report touched only briefly on the international phase of the controversy, saying that the effect of the diversion on boundary waters was pertinent "to the consideration of national interests . . . .and of the power of Congress to control the diversion with

[12] Hughes Report, page 73.

appropriate regard both to internal affairs and to foreign relations" and that in his opinion the treaty of 1909 can not be regarded as depriving the secretary of war of the authority over the diversion delegated to him by Congress.[13]

After hearing further argument on the case, the Supreme Court, in a unanimous decision delivered by Chief Justice Taft, January 14, 1929, declared the withdrawal of 8500 c.f.s. from Lake Michigan by the Sanitary District to be excessive, to be injurious to the proper interests of shipping and other interests on and along the Great Lakes, and ordered Mr. Hughes, after the taking of further testimony to determine how soon and to what extent a reduction of the amount withdrawn might safely be effected, to embody his conclusions in the form of a decree of the Court.

The decision upheld the previous report of Mr. Hughes as special master in so far as it concerned questions of fact but it differed from it in that it held the diversion should be very greatly reduced. It agreed with the special master that the secretary of war in granting the permit of March 3, 1925, had been acting under authority properly delegated by Congress but went on to say that the main purpose of this permit was to maintain the navigability of the Chicago River and of the port of the Chicago River which, sanitary questions aside, would, in the absence of the withdrawal of 8500 c.f.s. at that time, have become so silted up with sewage as to have become almost useless for navigation. In distinction from Mr. Hughes' report, the Supreme Court decision had nothing to say upon whether or not lake levels could or should be raised or maintained by compensatory works; nor did it in any way refer to the international aspects of the controversy, not even mentioning in its enumeration of the lowering of levels caused by the diversion, the undoubted lowering of some four inches at the harbor of Montreal.

The decision swept aside all claims of states in the lower Mississippi Valley as codefendants with the Sanitary District, interested in the use of the diverted water in the maintenance of higher levels in the Illinois and Mississippi Rivers, by saying that Congress had nowhere authorized the use of this water for any Lakes to Gulf Waterway and had in fact expressly stated that authorization of the construction of such a waterway was not to be taken as authority for any such withdrawal of Lake Michigan water. It again condemned in language only less severe than that

[13] Hughes Report. (Supreme Court of United States, October term, 1927, No. 7. Original, No. 11 Original, No. 12 Original. Report of Special Master.)

of Mr. Justice Holmes in his decision of 1925 what it termed the "inexcusable delays" of the federal court then presided over by Judge Landis; and while tacitly admitting by inference that the enforcement of a decree reducing the diversion would necessarily occasion the Sanitary District much trouble and expense it declared that they cannot now complain "because of their attitude and course" and it describes previous actions of the Sanitary District as having been not only without Federal authority but in direct defiance of it. The decision finds that the Sanitary District is however making progress in the installation of sewer disposal plants sufficient to warrant reduction of the withdrawal.

The court left the ultimate question of authority in the hands of Congress, merely in its decision interpreting past Congressional action without in any way passing on its relation to the international problem involved. This leaves the way clear for the State Department to enter into negotiations with Canada for the settlement of this question without any sense of being bound by the Court's decision.

In the presentation of its case, the Sanitary District has based its plea for 10,000 c.f.s. upon three main grounds. First that such withdrawal is an essential sanitary measure; second, that it is necessary to promote the completion of a navigable channel between Lake Michigan and the Mississippi River, linking together two of our greatest systems of inland waterways; and third, because it is alleged that what lowering of the lakes is caused by this diversion can be compensated for by the construction of regulating or compensating works at the outlets of Lakes Huron and Erie. The use of the water to improve the navigation between Lake Michigan and the Mississippi will be more fully considered in another chapter. The question of raising the level of the lakes by artificial structures is on the contrary a live one, the plan is practicable and it is not, in comparison with benefits to be derived, extremely costly. The Chicago Sanitary District, under one of the conditions of the permit of the secretary of war of March 3, 1925, has agreed to pay its share of the cost of such works and has posted a bond of $1,000,000 as evidence of good faith.

There are two principal ways in which the outlet of a body of water may be interfered with so as to raise the level of the main body. A dam may be built across it, provided with removable gates, and by closing these gates during slack water and opening them in flood the flow of the stream may be kept nearly constant and the level of the lake raised to any practicable level. Such a structure not only raises the level of the

lake but smooths out its normal changes of level. Works of this sort are known as regulatory works. The dam at the outlet of Lake Superior is an example of them.

But there is another way to raise a lake level. A submerged obstruction may be built across the outlet, wholly or in part, with the result that the flow of the outlet is impeded and the level of the lake raised until the increased head compensates for the reduction of the cross section of the channel. Such a structure, known as a submerged weir, has little effect upon the normal variations in level of the lake, it merely lifts them to a higher plane. The variations remain about the same, the mean elevation is raised. These devices are known as compensating works.

Both regulating and compensating works have been proposed at the outlets of Lakes Huron and Erie but only the latter have received the approval of the army engineers. The lakes are a peculiarly balanced system of reservoirs. Their surplus flow is extremely small as compared with the total volume of any of them; the level of each below Lake Superior depends on the overflow from those above it more than it does on water from its own drainage basin. It is estimated that the net rainfall over the Great Lakes basin, that is the rainfall less the amount of evaporation, is frequently insufficient for a period of months to maintain the overflow of the lakes.[14] In such times the level of the lower lakes depends upon excess water in the upper lakes and to restrain its run-off by dams would result in impossibly low levels in the lower channels. In other words it might be possible to dam the outlet of Lake Huron and so raise the level of that lake and of Lake Michigan in times of slack water, but the result on Lakes Erie and Ontario and upon the St. Lawrence would be lower water than ever before. A similar dam at the outlet of Lake Erie would have a similar effect on Lake Ontario and the St. Lawrence, with the added danger of ice blockades in the spring raising the water to such heights as to cause destructive floods to the valuable property along the lake front in the principal lake cities. Such dams would be extremely expensive, would require a lock for shipping and would be troublesome to navigation. For these reasons they are not favored by most competent engineers.

Compensating works are favored and are part of the plan for the St. Lawrence waterway. It is proposed to build a longitudinal dike along

[14] Hoover Report, page 17.

the Niagara River, constricting the stream. This dike is to be connected with the Canadian shore by a submerged weir with a crest a little below normal low water level. The effect of this will be increasingly manifest as the level of the river falls so that at low water the current of the stream will be diverted through the restricted channel. It will not interfere with the passage of ice nor with navigation which, except shallow draft vessels, now uses the Black Rock Canal from Buffalo harbor to Tonawanda past the location of the proposed dike. The cost of these works is estimated at only $700,000 and their effect would be to raise the low levels of Lake Erie by 8.4 inches and the high levels by a slightly less amount.[15]

For the outlet of Lake Huron it is proposed to build a series of submerged weirs straight across the channel of the St. Clair River. These weirs or rock sills will however have their crests thirty feet below low water stage and will therefore not affect navigation. Their presence will act as a brake on the flow of the stream and will so cause the level of Lakes Michigan and Huron to rise to about ten inches above present levels. The proposed works on the Niagara River will have an effect on these two lakes of about two inches so that the total effect of all the compensating works upon them will be about one foot. The cost of the works in the St. Clair River is estimated at $2,700,000.[16]

Taken together they would compensate for nearly all the lowering of lake levels due to all present diversions, which it is estimated have reduced the level of Lakes Michigan-Huron 1.15 feet and Lake Erie 0.7 feet.[17] The lowering of the level of Lake Ontario due to the diversion at Chicago, which is the only one that affects it, is four inches. This is already compensated for by the narrowing of the channel of the St. Lawrence by the Gut Dam above Galop Rapids. It would therefore be possible according to the estimates of the engineers to compensate for practically all the lowering of the lakes due to artificial diversions by the expenditure of $3,400,000. The estimated cost of regulatory works such as dams, gates, and locks is $36,400,000.

But there are natural changes in the lake levels which must be reckoned with. When it was noted by shipping interests about 1920 that their waters were ebbing to a point lower than any known since navigation

[15] Hoover Report, page 26.
[16] Hoover Report, pages 22 and 26.
[17] Hoover Report, page 22.

had assumed any large importance, they were disposed to put most of the blame on Chicago and its drainage canal. The same attitude was taken by the big power interests at Niagara which as it happens are chiefly on the Canadian side. But the most extreme estimate of the lowering due to the Chicago Canal by any competent engineer is not more than seven inches while the decline in the level of Lakes Michigan and Huron amounted, in 1925, to nearly three feet below normal. Lake Erie at the same time was about fifteen inches below normal level and Lake Ontario about a foot. But the same was true of Lake Superior, which as we have seen, is not at all affected by the Chicago diversion.

It seems evident that this great lowering of lake levels was due principally to climatic conditions. Weather Bureau records in the United States and Canada show that in the decade beginning in 1916 the precipitation was decidedly below normal over the whole Great Lakes basin. The only exceptions to this were the year 1921 when it was a little above normal over the upper Lake region and 1925 when it exceeded the normal over the basin of Lake Ontario. Over the basin of Lakes Michigan and Huron the deficiency averaged 1.7 inches a year for eight years, or a total for the period of 13.6 inches while over the drainage area of Lake Superior the deficiency was still greater, amounting during the eight years from 1916 to twenty-three inches or nearly three inches annually. This would certainly seem to account for the larger part of the decline in lake levels noted during the first half of the present decade. Increased rainfall in 1926 started a reaction toward higher levels which was progressive during 1927. These changes are typical of the lakes. The highest level of Lake Erie in the past thirty-seven years was reached in 1913, while about five years later Lakes Michigan-Huron attained their highest level since 1889. Both of these periods of high water were long subsequent to the opening of the Chicago drainage canal. It is true however that the low lake levels of 1925 had not been equalled in fifty years although it appears that in 1819 the level of Lake Michigan was a little lower than in 1925.[18]

The levels of the lakes are seen then to depend upon the two factors of Nature and Man. What Nature does not do in the way of supplying water, Man can not wholly remedy save at enormous expense and with doubtful benefit; but he can repair his own depredations on the normal level of the lakes. It will pay him to do this. A lowering of the levels

[18] *Monthly Weather Review*, March, 1926.

of the lakes means a shallowing of the channels and harbors; it means very definitely that the big bulk freighters that carry most of the trade of the lakes must each leave ashore tons of otherwise profitable cargo. Assuming twenty feet as the average draft of the bulk freighter, every reduction of this by one inch reduces the carrying capacity of the vessel by ninety to one hundred tons,[19] so that the loss due to the Chicago diversion alone amounts to from 450 to 600 tons per trip. During a season of twenty trips the lost cargo amounts to from 9000 to 12,000 tons. Assuming the average freight revenue of the bulk freighter to be the very moderate sum of sixty-seven cents a ton,[20] this means a loss per vessel of at least $6,000 per season and as in 1925 there were 626 bulk freighters on the lakes the total loss from the Chicago diversion alone may be roughly estimated at a minimum of $3,750,000 a year, or more than the total cost of constructing compensating works. The construction of these works would not merely prevent this loss but they would be a positive gain, for by increasing the carrying capacity of the lake fleet they would permit lower freight rates which would be passed on to the consumers or producers of goods so carried.[21]

Furthermore such a raising of lake levels is absolutely essential to the St. Lawrence waterway plan. Without higher levels it would be almost impossible, even by dredging, to permanently maintain twenty-five-foot depths in the channels and harbors of the upper lakes, to say nothing of thirty-foot depths, and it needs only the most elementary understanding of the problem to see that a plan which permitted ships of twenty-five or thirty feet draft to ascend to Lake Ontario or even to Lake Erie but which did not permit them to enter the harbors of Cleveland, or Toledo, or Ashtabula, to say nothing of entering Lake Huron and the two great lakes beyond, would be foredoomed to failure as an economic enterprise. How the cost of compensating works is to be allotted is not within the province of this book which does not intend to act as a judge between Chicago, Canada, the shipping and power interests, and the climate of the lake basin. Chicago has perhaps pursued a selfish policy; but the opposition to what that city considers a vital need has not been unselfish, not unmindful of added freight revenue nor of the added value of water falling over the Niagara escarpment rather than over the dam at Lockport, Illinois.

[19] *Transportation on Great Lakes*, page 36.
[20] Average rates in 1923 were eighty-eight cents a ton.
[21] Hughes Report, page 114.

Since the above was written, Prof. H. C. Frankenfield, Chief of the Rivers and Floods Division of the United States Weather Bureau, has informed the writer that at the end of November, 1928, the level of Lakes Michigan and Huron was fifteen inches above the November average of the previous ten years; the level of Lake Erie about four inches above and the level of Lake Ontario about seven inches above similar November averages. Lake Superior's level had risen slightly more than had that of Lakes Michigan and Huron. The rise was then apparently still continuing on all the lakes as all showed increases for the previous year, the amounts varying from a little less than eight inches for Lake Erie to a little more than twenty inches for Lakes Michigan and Huron.

CHAPTER IX

Other Routes to the Sea

There are few human problems which admit of but one solution, and there are fewer still of which it may be truly said that the one solution is perfect in all details. Life is a series of compromises with necessity.

How to open the middle west to the commerce of the world on approximately equal terms with its chief competitors in agriculture and industry; and in particular, how to do it by means of waterways, is just such a problem. There is more than one solution and not one of them is perfect. The St. Lawrence waterway is not the only one that is practicable from an engineering standpoint and it has some drawbacks that others do not, or at least not in so large measure, while others have advantages over it from one or more points of view.

There are four other possible waterways from the Great Lakes to the sea. One is already in operation. It is the New York State Barge Canal and it is not a distinguished success. It is not a ship canal. Another possibility resembles it in being only a barge route, the proposed Lakes-to-Gulf Waterway down the Illinois and Mississippi Rivers. While a few enthusiasts pretend to believe in the practicability of a ship channel for this entire distance, the most reasonable advocates of the scheme propose merely a nine-foot depth. This would link the lakes to the waterway system of the Mississippi and the Ohio but it would be in no sense a sea-way for sea-going craft. It will be more fully considered later together with the New York Barge Canal. But there are two other ship canals proposed besides the St. Lawrence waterway from the lakes to tidewater. One is wholly in Canada, from Georgian Bay up the French River to Lake Nipissing, thence to the Ottawa River and down that stream to its outlet into the St. Lawrence at Montreal. The other is wholly in the United States, from Lake Ontario at Oswego to the Hudson at Albany, closely following the route of the present barge canal.

Of these two routes the latter is the only one under serious consideration at present. It has many energetic advocates; it has some advantages; it is supposed to have more. It has many disadvantages and the best informed opinion is that they would be fatal to its success. It would

cost more than $500,000,000. It would develop no significant amount of waterpower and while it would be wholly within the United States that advantage would be most illusory and would mean moreover that this country would have to pay the entire cost of construction. Fundamentally it is a political scheme, born of jealousy and ignorance. It has been repeatedly condemned by United States Army engineers but its advocates are so insistent and so vehement that it seems only fair to give them a hearing here and then to show the present utter fallacy of their proposals, which, if effected would mean the unloading of a gold brick costing the taxpayers of the country half a billion dollars so that the port of New York and the railroads serving it might still continue to prosper.

The New York State Barge Canal begins at the head of navigation of the Hudson River at Troy. From what is approximately sea-level it ascends through the valley of the Mohawk River to the upper waters of that stream and thence across a short stretch of nearly level country to Oneida Lake. The summit level, 420 feet above sea-level is reached here, the canal then descending to Oneida Lake at a level of 376 feet. The canal then follows the course of the Oneida River to its junction with the Seneca to form the Oswego River at Three Rivers. The main canal extends westwards to Tonawanda but a branch follows the course of the Oswego to the city of that name where it joins Lake Ontario at an elevation of 246 feet above the sea.

The proposed Oswego-Hudson Canal would closely follow this course and would use in large part the channel of the present canal which would of course be deepened to twenty-five feet. One plan proposed building a new harbor west of Oswego, beginning the canal there and joining the route of the present canal some eight miles up the Oswego River. By another plan the new canal would again leave the course of the old at Rotterdam Junction, west of Albany and would follow a new channel by way of the valley of Norman's Kill to the Hudson just below Albany. Both of these variants depend upon engineering considerations which time may make of small value and the latest report of the engineers is rather favorable toward following the route of the present canal very closely. How does this route compare with that down the St. Lawrence from Lake Ontario to Montreal?[1]

To begin with, it traverses a much more highly developed terrain.

[1] Waterway from Great Lakes to Hudson. House Document 288, First Session, 69th Congress.

The St. Lawrence waterway would follow the course of that river through a thinly settled valley, having no large cities and few small ones; where railroads and highways crossing the course of the waterway are few, and where land is cheap. The proposed Ontario-Hudson Canal would traverse the heart of New York State. It would pass through a highly developed region, thickly settled, with three cities of more than 100,000 population and many smaller ones along its course; a land covered with a network of expensive roads and railways where land values are high. Geographically, the St. Lawrence waterway would run down hill while the Ontario-Hudson would climb 174 feet to the summit level and then descend 420 feet to the sea, a total of 594 feet of elevation to be overcome as compared with 226 feet between Lake Ontario and the harbor of Montreal.[2]

When these differences are translated into terms of construction and operation they present the advocates of the Ontario-Hudson Canal with some hard reading. The St. Lawrence waterway is longer by some thirty miles than the Ontario-Hudson but the latter would have 128 miles of restricted canal navigation as compared with from twenty-one to twenty-five miles via the St. Lawrence. The route across New York State would require fifty-four bridges, forty-nine of them drawbridges,[3] many of them of a most expensive character, all except five obstructive both to land and water traffic; the St. Lawrence route would require only eight bridges. The difference in terrain is reflected in the difference in the number of locks required by the two proposed waterways, the St. Lawrence would require eight or nine, the Ontario-Hudson twenty. The cost of the St. Lawrence channel alone, exclusive of any waterpower development would be not more than $175,000,000; the expenditure of $225,000,000 more would result in the development of 2,730,000 horsepower of energy and a channel deep enough for vessels drawing twenty-five feet; all this expense would be shared by the governments of the United States and Canada.[4] The New York project would cost $506,000,000 for a similar channel,[5] there would be no material offset from power development, the full expense would be met by the United States.

[2] Waterway, Great Lakes-Hudson, House Document 288, First Session, 69th Congress.

[3] Great Lakes-Hudson, Supplemental Report, House Document 7, Second Session, 69th Congress.

[4] Hoover Report, pages 5 and 49.

[5] Waterway, Great Lakes-Hudson, House Document 288, First Session, 69th Congress.

Furthermore, for reasons shortly to be given, this huge outlay would not justify one of the alleged reasons for the construction of an Ontario-Hudson Channel unless there were spent $125,000,000 more for the construction of a similar canal around Niagara on the New York side. The Ontario-Hudson Canal with this added shipway around Niagara is known as the All-American Canal. It would cost $631,000,000 exclusive of interest charges during construction.

One of the main reasons given by proponents of the All-American project is its use to this country in time of war. It is pointed out very truly that the lower course of the St. Lawrence is wholly through Canadian territory and that Canada might close the channel in war time to United States merchant vessels carrying munitions. Further it is alleged that if Canada were on the enemy side it would be possible for enemy warships to ascend to the lakes and bombard or lay under contribution the rich lake cities. It is therefore said to be essential to our peace and safety not only to build a ship canal through our own territory from Oswego to the Hudson but to parallel the Welland Canal with a duplicate on our side of the border so that we might always be assured of safe passage of our cargoes from the lakes.

Considering these alleged reasons in order it may be pointed out that Canada has already been a neutral in a war in which the United States was engaged and the United States has twice been a neutral in a war in which Canada was engaged yet in neither case has there been any restraint of lake or river commerce. Canada was neutral during our war with Spain; we were neutral when Canada was at war with the Boers and for two years and eight months of the time she was at war with Germany; yet in every case the shipping of belligerents was freely permitted to traverse the St. Lawrence or Lake Michigan where each is wholly within the territory of one nation or the other. As to war vessels we are limited by treaty to small coast guard patrols on the lakes which would be valueless at sea and whose internment in the lakes would be of no military significance.

But, it is hinted, suppose we were at war with Canada or with Great Britain and Canada together? What would prevent British cruisers from bombarding Chicago if the St. Lawrence waterway were built? To begin with, this is a sorry supposition. But it is not impossible. What has happened can happen again. We have twice in our history declared war upon a weaker neighbor on or near this continent and if Canada underestimates our jingoism she might read with profit the

history of Spain and of Mexico during the past eighty years. We have twice been at war with Great Britain and in each case Canada was an enemy country. Facts might as well be faced and although one of the mightiest facts is that a war between the United States and Great Britain or Canada or both would be either a shameful misuse of strength or a world tragedy that would probably set back civilization from five hundred to a thousand years, still, this is an irrational and unhappy world in which such things have happened and may happen again and again.

But, assuming the worst, what good would an All-American Canal do us in such a war? Its chief use would probably be for the shipment to the seaboard of wheat and iron ore and to the interior of rubber and fancy ores used for high-grade steel. Nearly all the wheat and practically all the iron ore would have to come through the Soo locks. These are about half a mile from Canadian territory. The rubber and fancy ores would have to pass through the canal around Niagara, one end of which would be at Tonawanda with Canada less than a mile away. How long do any of our super-patriots suppose it would take Canada to destroy the locks at both places, or for that matter to mine that part of the Detroit River channel which is wholly in Canadian territory? Furthermore, all the canal from Oswego to Albany would be within easy airplane bombing distance from enemy soil.

On the other hand would the prevention of the building of a St. Lawrence waterway through the building of an All-American one have any protective value to our soil? Not a bit more than good artillery and bombing planes would have. Assuming the existence of a St. Lawrence ship channel big enough for British cruisers; not only could the locks of the canal or of the new Welland be easily destroyed from our side by airplanes or long range artillery but the 116 miles of the St. Lawrence where it flows by our territory could be absolutely commanded by our artillery. In this connection it is interesting to note that one of the first extensive canal projects in Canada, the Rideau navigation from Ottawa to Kingston, was proposed as a safeguard to Canadian traffic from Lake Ontario to Montreal which during the war of 1812–1814 had been seriously interrupted by the military command of the St. Lawrence by the forces of the United States. The argument for the All-American Canal on military grounds is one that has been contemptuously rejected by every military authority and is one of the biggest pieces of nonsense ever offered by politicians to a sentimental but ill-informed public.

Another reason put forward by its advocates in favor of the All-American Canal is that the steamship route from northern Europe to the lower St. Lawrence is beset with storms and ice and fog while the routes to New York are relatively free from such dangers. Ice is a menace to ships entering the St. Lawrence for the greater part of the navigation season but how little influence this has on shipping is seen in the fact that the foreign commerce of the port of Montreal is greater than that of any other Atlantic port except New York. The same might be said of fogs. The sea around the south coast of Newfoundland is frequently covered with dense fog during the navigation season and much of these fogs can be avoided and is avoided by vessels entering New York on a southerly course, but fogs near the Straits of Belle Isle at the northern entrance of the Gulf of St. Lawrence are less frequent and since this is the channel that would be used by most of the trade to northern Europe the objection raised because of fog has less force than that due to ice, which, as we have seen is not serious enough to deter shipping from entering the St. Lawrence. Not merely shipping but almost the highest type of ocean vessels, for the size and tonnage of the largest vessels entering the St. Lawrence and destined for either Montreal or Quebec is exceeded only by the great express liners that use only the port of New York.

It is also stated that since the route of the All-American Canal is farther south than that of the St. Lawrence the season of navigation would be longer. This amounts to little. No chain is stronger than its weakest link and while New York harbor is never closed by ice and the channel to Albany is open nine months of the year, the length of the navigation season would be determined by the freezing up of the canal and of Oneida Lake, or by that of the Welland Canal. Since the opening of the present New York Barge Canal the date of opening has been set close to May 1 and of closing about December 5, or a season of about 218 days. During the past twenty years the average period of navigation on the Welland Canal has been from April 18 to December 16, or 242 days, while for the same period the St. Lawrence canals above Montreal have on the average been open from April 26 to December 9 of 227 days.[6] Assuming that the All-American route could be kept open as long as the Welland, the advantage of the All-American over the St. Lawrence would be but little more than two weeks. But this assumption, when compared with the actual performance of the present

[6] Hoover Report, page 11.

barge canal across New York State is doubtful. Central New York has a somewhat colder winter climate than the peninsula between the lakes through which the Welland Canal passes and it seems almost certain that the average season of navigation on a ship canal across the state from Oswego would not be more than perhaps a week longer than through one down the St. Lawrence.

But this slight and doubtful advantage is more than offset by the difference in the time required to make the two canal passages. The distance from Oswego to the Hudson by the proposed new canal is estimated at about 179 miles by some of its opponents but the figure is based upon the length of the present barge canal and is too high since the plans for the All-American Canal call for a waterway some fifteen miles shorter. The report of the St. Lawrence Commission gives the length of restricted navigation in the Oswego-Hudson Canal as 128 miles.[7] If to this be added the length of open navigation in the twenty-five miles of Oneida Lake and through the long summit level of thirteen miles, the total figure will be seen to check with the estimates given. Assuming this lower figure we may proceed to calculate the time required for the passage of a vessel through the canal. Let us assume the speed in open water to be twelve statute miles per hour which is about the average for ocean freight vessels. But this speed would be possible nowhere except when crossing Oneida Lake. This would occupy two hours. Five miles an hour would be the rate through the canal and since there would be about 140 miles of it, the time required would be twenty-eight hours more. An hour's delay in passing every lock should be reckoned on. This would mean an additional twenty hours. Finally there would be forty-nine bridges to be encountered, and allowing twenty minutes delay for the passage of each bridge the resulting delay would amount to at least sixteen hours. Adding these estimates together we get a total time of sixty-six hours required to make the 164 miles from Oswego to Albany.

From the outlet of Lake Ontario to Montreal is 183 miles by the proposed St. Lawrence waterway. The first 115 miles are open steaming where a speed of twelve miles per hour would be possible. Ten hours would bring our vessel to the beginning of restricted navigation. However, forty-five miles of this would be relatively so open that a speed of nine miles an hour would be permissible carrying the ship through in five hours. Restricted canal navigation would take nine hours.

[7] Hoover Report.

There would be nine locks, each requiring an hour. There would be eight bridges and if all were drawbridges the time to pass them would not require more than three hours, making a total of thirty-two hours required to bring the ship through from Lake Ontario to Montreal harbor.

But the comparison does not end there. Taking Liverpool as a typical north European port, the distance from it to Montreal is 3207 statute miles;[8] the distance to New York by the shorter winter course is 3578 miles,[9] a difference in favor of Montreal of 371 miles, or thirty-two hours steaming by a vessel of the speed assumed. The total distance, Duluth to north European ports is about 500 miles shorter via the St. Lawrence.

The Department of Commerce, using this method of calculation has concluded that it would take a twelve-mile an hour ship approximately sixteen days and twenty-one hours to go from Duluth to Liverpool via the St. Lawrence waterway, and nineteen days and fifteen hours via the Oswego-Hudson Ship Channel. It is only fair to say that for vessels bound to south Atlantic or Pacific ports the advantage of distance would be in favor of the New York route by from 500 to 1500 miles but this advantage would be somewhat offset as we have seen by the better inland navigating conditions along the northern route.

There are two alternative routes for a ship canal from the lakes to New York harbor which deserve a few words and no more. One proposes to deepen the whole length of the present barge canal from Albany to Buffalo. This would be double the length of the proposed Oswego-Hudson Canal which is estimated to cost $506,000,000. The proposed billion dollar canal to Buffalo would enable ships to pass from Lake Erie to New York in a few hours more time than would be required for them to go by way of the Welland Canal and Oswego. Enough said.

The third alternative follows the St. Lawrence to Lake St. Francis from whence a canal would be dug to Lake Champlain. Vessels would traverse that lake and descend to the Hudson by way of an enlargement of the present barge canal, a branch of which follows that route at present. The disadvantages of this route are that it is longer than the Oswego-Hudson and would require more time to navigate; it would have a slightly shorter season of navigation; it would cost more; and part of it would be wholly within Canada and would require before building the consent of that country. Furthermore it would be handing the Cana-

[8] Tables of Distances, United States Hydrographic Office.

[9] The summer route New York-Liverpool is 3707 statute miles.

dians a large part of the St. Lawrence waterway as a gift. It would then be possible for them at relatively small expense through the construction of a waterway only thirty miles long, to complete the deep channel from the lakes to Montreal and so to divert traffic from the port of New York to their own commercial capital. The possible development of 1,300,000 horsepower would be an added incentive.

Before leaving this subject of ship canals from the lakes to the Atlantic a few more words are due the proposed channels around Niagara which form part of the proposed All-American plan. The most practicable is that from La Salle on the Niagara, around the falls to Lewiston and so by way of the lower Niagara River to Lake Ontario. This would cost about $125,000,000 for a twenty-five-foot channel, is the cheapest, and could be navigated in less time than the Tonawanda-Olcott route which would ascend the line of Tonawanda Creek from the upper Niagara, follow the present barge canal to Lockport and descend thence to Lake Ontario through the valley of Eighteen-Mile Creek. The most preposterous scheme of all is for a canal which would leave Lake Erie south of Buffalo, cut back of that city to Lockport and so by the Tonawanda-Olcott route to Lake Ontario. This route would cross every one of the fifty-two railways and eighteen highways entering Buffalo, requiring at least seventy bridges. It would be forty miles long and would probably cost $200,000,000 to build. It has been condemned by every competent engineer and seems now to be quite dead.

These routes cover every proposed ship canal on the United States side of the lakes. There remains one other practicable route, the Georgian Bay-Ottawa River. This follows the old trail of the fur trader in the days when the ferocious Iroquois barred the French from Lake Ontario and the Niagara portage. It ascends the Ottawa River nearly to its source, then crosses to Lake Nipissing from which it descends by way of French River to Georgian Bay, the great estuary of Lake Huron. This route would be 440 miles from Lake Huron to Montreal and the differences in elevation would require twenty-seven locks to overcome a rise of 659 feet from Montreal to the summit and a drop of ninety-eight feet from there to Lake Huron.[10] The cost of a twenty-two-foot channel with locks large enough to accommodate the largest lake steamers was estimated at $100,000,000 in 1908. For a twenty-seven-foot channel at the present time the cost would be probably nearly twice this sum.

[10] *St. Lawrence Waterway*, page 34.

There would be large possibilities of waterpower but these would be so far from the industrial cities of Canada as to be unprofitable for present development. Except from the Canadian viewpoint, this project has little to commend it. It would reduce the distance by water from Montreal to Lake Michigan and Lake Superior points by about 350 miles but this apparent advantage would be entirely lost through the inherent difficulties of canal navigation. The passage from Montreal to the head of Lake Huron would require at least four and a half days, while by the St. Lawrence waterway the time would be less than four days. For Lake Erie points the St. Lawrence route would be from two to three days shorter. The navigation season on the Georgian Bay route would be about two weeks shorter than that of any other ship canal. Its only advantage would be from the Canadian nationalistic point of view for it would be wholly within that country and far enough from the border to be subject only to air attack in case of war. For this reason it would be a possible menace to the United States since it might be possible to bring fairly powerful warships through it and into the upper lakes. It is, however, a doubtful project. If built it would be by far the longest ship canal in the world and would have the most locks, conditions which would be a powerful deterrent to its use by ocean shipping. It is opposed in Canada for the same reasons that the St. Lawrence waterway is opposed; that it would benefit the United States more than Canada and western Canada more than Montreal and Quebec. It now appears to be dead.

These three projects; St. Lawrence, All-American, Georgian Bay, exhaust the possibilities for a practicable ship canal from the lakes to the sea. Sooner or later, unless there are revolutionary and unforeseen changes in the economics of transportation, one of them will be built. The chances are that the one chosen will be the St. Lawrence. It is not without disadvantages from either the Canadian or United States point of view, or from the point of view of unprejudiced engineers, but it has fewer of these drawbacks and more advantages than any other plan. Opposition to it is almost wholly to be divided into two groups, those who honestly believe that no ship canal to the lakes can succeed, and those who fear that such a canal would be such a success as to injure the prosperity of seaboard cities or of the railroads which serve them. There is a still narrower opposition in New York State which fears the influence of such a ship channel upon the fortunes of the state barge canal.

Engineering and economic arguments in favor of the waterway have been already outlined and some of the objections discussed. The objections from seaboard cities based upon fear for their own interests seem short-sighted. If there is any demonstrable truth in the economic history of mankind it is that transportation begets the need for more transportation. The development of the railroads in this country would never have been so rapid had not the canals shown the advantage of cheap and quick transport; while in their turn the railroads and the invention of the automobile begat the movement for improved highways. It is becoming increasingly doubtful whether the expensive equipment of the railroads can best be used to carry bulk freight at low rates if waterways are available. The measure of this doubt is the increase in railroad rates on these commodities. This, in turn handicaps the producers and consumers of these raw materials and lowers their purchasing power for high grade goods which the railways can transport most profitably. The seaboard cities fail to see that if a shipway to the lakes resulted in the greater economic prosperity of that region it would be reflected in a greater demand for their own peculiar products and in a greater foreign trade in high grade goods most cheaply handled through their own ports. To take an extreme example; the Panama Canal has undoubtedly helped the prosperity of the Atlantic coast states and it has undoubtedly made unprofitable the rail transport of grain and lumber from coast to coast, but the increased demand for luxuries in the east has resulted in more fast silk trains from Pacific ports to eastern mills, a most profitable form of railroad traffic.

In his letter of transmittal of the report of the St. Lawrence Commission, of which he was chairman, Secretary Hoover stated:

"There has been some feeling that the construction of the St. Lawrence waterway will injure the interests of our eastern states by decreasing terminal business of lake and seaboard cities; will divert traffic from American railways and endanger our commercial and financial control of American exports and imports over this route. Of first importance is the fact that the total estimated tonnage available today for the waterway amounts to under four per cent of the present tonnage carried by the American railway systems which now connect the Lakes with seaboard. It comprises less than twelve per cent of the sea shipments now moving through the affected American seaports. The natural increase in population and traffic would quickly recover such amounts theoretically before the earliest possible completion of the waterway."[11]

[11] Hoover Report, page 6.

Similarly, the report of the Joint New England Committee on the St. Lawrence waterway, composed of thirty leaders in the financial, transport, and industrial activity of that region, found that the gain to New England from cheaper food and other raw material would more than offset any possible loss due to diversion of traffic.

Political opposition seems unworthy, foolish, and above all, insincere. The rights of both countries in the navigation of the lakes were determined in the treaty of 1871 between the United States and Great Britain which provided that,

> "Navigation of the River St. Lawrence, ascending and descending from the 45th parallel of north latitude, where it ceases to form the boundary between the two countries, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to citizens of the United States."

A similar provision with respect to all navigable boundary waters between the two countries is part of the treaty of 1909 which also extends its application to the waters of Lake Michigan, and in all these provisions of both treaties it is expressly stated that these rights are limited only by local regulations of either country, "not inconsistent with the privilege of free navigation" and applying equally to all.

Most of this political opposition to the St. Lawrence waterway emanates from advocates of the All-American Canal or the present New York Barge Canal, and nearly all of such opposition is ignorant or selfish. The case for the waterway is just this. A better outlet from the midland states to the sea is imperative. There are five possible waterways, three of them ship canals, which in the opinion of all competent to judge, furnish the only real solution. One of these is so nebulous in outline as hardly to need consideration. The real choice is narrowed to the St. Lawrence and the All-American. The former is shorter, cheaper, more practicable. The present fourteen-foot canals down the St. Lawrence carry close to their full capacity of 8,000,000 tons of freight a year. The New York Barge Canal along the route of the All-American, has a capacity of 20,000,000 tons and carries less than half the traffic of the St. Lawrence canals. The St. Lawrence is the natural outlet, not only of the waters of the lakes but of their commerce.

But there remain two auxiliary outlets of importance. One, the New York Barge Canal, has been repeatedly referred to. The other is the proposed nine-foot channel from Lake Michigan to the outlet of the Mississippi. Each is an important integral part of our system of inland waterways and both will be presently described.

CHAPTER X

Barge Canal Outlets from the Lakes

When the Iroquois confederacy still held sway over all central New York, blocking the valley of the Mohawk to traders from the east, French pioneers and missionaries were exploring all the upper lakes. It was well into the eighteenth century before their English rivals had established a trading route to the inland seas, that by way of Oswego. It was to be nearly a century more before that route would be extended by means of the Erie Canal to Lake Erie. But before the seventeenth century was over, the French had discovered the other great auxiliary trade outlet of the lake region, that across Illinois to the Mississippi.

Joliet and Marquette were, as we have seen, its discoverers. After their historic cruise down the Mississippi which they entered from the Wisconsin River farther north, they returned up the Illinois and the Des Plaines, made a short portage of their canoes to the Chicago and in a few hours were cruising the waters of Lake Michigan. The two explorers saw the advantage of a canal at this point but the project waited for just about one hundred and fifty years. During this interval, however, small boats sometimes actually crossed from one watershed to the other. The crest of the divide is only about eight feet above the lake and during high levels of the lake and flood stages of the rivers it was sometimes possible to make the crossing without any portage. These facilities were enough for the primitive population of Indians, trappers and fur traders but when after the Revolution all the Northwest Territory fell to the United States and especially after the development of steam navigation along the Ohio had turned the tide of settlement toward the Illinois prairies, the need of better transportation was keenly felt. The railroad was still far in the future.

About the same time that the first steps were being taken toward the building of the Erie Canal, Congress was becoming interested in a Lake Michigan-Mississippi waterway. A resolution urging that such a canal be built was passed in 1810 and six years later a treaty was made with the Indians then in possession of northern Illinois by which they ceded to the federal government a strip of land twenty miles wide along the watersheds of the Chicago, Des Plaines, and Illinois Rivers. Illinois

was admitted to the Union in 1818 and following a favorable report by army engineers and a formal recommendation by John C. Calhoun, Secretary of War, Congress in 1822 passed an act authorizing Illinois to build the canal through federal lands. The state apparently preferred to let Uncle Sam do it and memorialized Congress to that effect in 1826, but the only response from the federal government was the act of 1827 which ceded 284,000 acres of land lying along the route of the proposed waterway on condition that it should be used only for canal purposes and that the canal when built should always be free of tolls to the government of the United States or persons in their service.[1]

Illinois authorized the canal after nearly a decade of political wrangling about it. Construction was begun in 1836 and it was opened for traffic in 1848 at a cost of a little more than $6,500,000. It was about ninety-seven miles long, extending from the South Branch of the Chicago River at a point about seven miles from Lake Michigan to the Illinois River at La Salle. It was six feet deep and forty feet wide and was fed in part by Chicago River water, pumped into the summit level. This was soon seen to be a useful way of purifying the sewage polluted waters of that already malodorous stream and in 1871 the city of Chicago completed the dredging out of the summit level of the canal to a depth which permitted a flow from the Chicago River of about 670 c.f.s.[2]

The canal was thus partly a navigation and partly a sanitary work until the opening of the Chicago Drainage Canal in 1900. This paralleled it as far as Joliet where the drainage canal joined the Des Plaines River and as the latter had a depth of twenty-one feet it soon drew all of the through traffic which the old canal had formerly enjoyed. This part of the canal somewhat more than thirty miles long is now obsolete, practically abandoned. Through traffic uses the Drainage Canal. The remaining portion of the waterway is in rather poor condition being impassible for boats drawing more than four feet. It has eleven locks in sixty-four miles during which its level falls nearly 100 feet. The total construction cost up to the present has been close to $10,000,000, the last work having been done during the World War when the channel was made safe for boats of four feet draft. About forty years ago an effort was made to sell the canal to the federal government but the bill failed to pass Congress in 1888. Toll and lockage charges are made, the former being on a mileage basis.

[1] *Waterway Great Lakes to Gulf of Mexico.*
[2] *Waterway Great Lakes to Gulf of Mexico.*

The economic history of the Illinois and Michigan Canal parallels that of all the canals of its type. For about twenty years it did well, then railway competition became increasingly severe until in 1916 it carried only 267 tons of freight. Improvements since then have somewhat increased its usefulness but in 1926 its traffic amounted to only 466 tons. If it were not for its peculiar location and for the importance of the waterways with which it connects, this old ditch might be allowed to die the death that has overtaken so many of its peers. But it has on one side the huge commerce of the Great Lakes; on the other the rapidly growing commerce of the Mississippi; it is the link between our two great inland waterway systems and it is not therefore surprising to find it an important, even essential factor in the development of a national waterway system.

The Illinois River is, next to the Ohio, the most important eastern tributary of the Mississippi. It is formed by the junction of the Des Plaines and Kankakee Rivers 273 miles above Grafton, Illinois, where it enters the Mississippi twenty-two miles above the mouth of the Missouri on the western bank. It is a quiet, rather sluggish stream with a fall of only thirty feet from Utica to its mouth, a distance of 230 miles. Its width varies from 600 to 1400 feet except for a short distance where, at Lake Peoria, it widens to about a mile. The Des Plaines River rises along the western slopes of the nearly flat divide separating its watershed from that of the Chicago River less than ten miles west of Lake Michigan and within a mile or two in places of what was once the natural channel of the Chicago River. That stream is formed of two branches uniting 1.6 miles from its mouth and the South Branch is now a part of the Drainage Canal through which the water of Lake Michigan flows for thirty-three miles to enter the Des Plaines at Joliet, fifteen miles above its junction with the Kankakee to form the Illinois. Such is the geographical picture of the territory between the outlet of the Illinois and Lake Michigan. It will be seen that the canal and the rivers form a continuous waterway across the state.

It is continuous but it is very variable as to depth. The Drainage Canal is twenty-one feet deep, the Illinois and Michigan Canal is a little more than four, while the Illinois is being given a depth of nine feet from its mouth to Utica. From the lock and power plant of the Drainage Canal at Lockport, three miles above Joliet, to Utica, a gap of sixty miles separates the twenty-one-foot depth of the canal from the seven-foot depth of the Illinois River. This gap the state of Illinois is bridging by

the construction of a waterway with a least depth of nine feet with locks 600 feet by 110 and with fourteen feet of water on the sills.

From the mouth of the Illinois there is a least depth of six feet in the channel of the Mississippi for the thirty-six miles to St. Louis. Below St. Louis the channel depth is eight feet for the 191 miles to the mouth of the Ohio at Cairo and from there 1081 miles to the Gulf of Mexico the least depth of the channel is nine feet. In order then to complete a nine-foot waterway from Chicago to the Gulf it will be necessary to further deepen the channel one foot from Cairo to St. Louis, and three feet from St. Louis to the mouth of the Illinois, in addition to the deepening of the Illinois now authorized. This nine-foot depth is the same that is provided for in the improvement of the Ohio River, now nearing completion. The deepening of the Mississippi and Illinois does not mean of course that the whole channel must be dredged for the entire distance, merely that a channel must be cut through occasional sandbars. In the Illinois River the depth will be maintained by dredging and by two locks and dams. Including the Sanitary and Drainage Canal and the Illinois Waterway there will be seven locks between Chicago and the Mississippi.

The whole nine-foot Lakes to Gulf project is closely tied up with the famous Chicago diversion controversy, so much so that opponents of that diversion assert that Chicago's enthusiasm for the waterway is based not upon any great love for inland navigation but rather upon a keen longing for more Lake Michigan water to dilute the city sewage, make expensive purification unnecessary, and also to develop valuable power at Lockport. If Congress can be convinced of the need of 10,000 c.f.s. flowing out of Lake Michigan through the Drainage Canal and into the Illinois in order to make possible a nine-foot channel therein, it will save Chicago a great deal of money. That may not be the only reason why Chicago favors the nine-foot channel but it is perhap significant that about three-fourths of the 194-page booklet on the Lakes to Gulf Waterway published in 1926 by the Sanitary District of Chicago is devoted to the necessity of a 10,000 c.f.s. diversion for sanitary and navigation purposes. The whole emphasis is on the diversion.

Be that as it may, it is certain that the cost of any improvement of the existing channel from Utica to St. Louis depends very largely upon the amount of water available from Lake Michigan. This is especially true in the Illinois River. The present seven-foot channel in that stream below La Salle, a distance of 223 miles, is maintained by four dams and

by dredging. It needs only a glance at the problem to see that if the flow of the river could be increased a greater depth might be obtained without dredging and that were the flow sufficiently great the dams and locks might be dispensed with because the slope of the stream is so slight that an increased volume of flow would mean only a slight increase in current velocity—not enough to be a navigation factor. The present flow through the Drainage Canal averages about 8500 c.f.s. Should this be substantially maintained or even reduced to 7500 c.f.s., the United States Army engineers estimate the nine-foot channel from Utica to Cairo will cost $3,000,000, while if the flow should be reduced to the limit of the original permit of the secretary of war, 4167 c.f.s., the cost would be raised to nearly $6,200,000. The engineers believe, however, that even with the minimum diversion from Lake Michigan the present dams might be removed and the channel depth wholly maintained by dredging. With a diversion approximating that existing in 1927, they would not be needed.

For these reasons the United States Army engineers reported in 1921 and 1922 against a nine-foot channel which they thought would be too expensive for any benefit likely to be derived. They advised the construction of a seven-foot waterway for the whole distance from Utica to St. Louis, which might be built according to their estimates for $736,000 and with annual maintenance charges of $47,000 as against $650,000 for the deeper channel. This is assuming a Drainage Canal flow of 4167 c.f.s. With the flow fixed at 7500 c.f.s., the construction cost would be only $425,000 and maintenance about the same as with a smaller flow. For an eight-foot waterway the construction estimate was $1,930,000 and about $152,000 annual maintenance with a diversion flow or 7500 c.f.s., or more, and construction cost of approximately $2,400,000 with a diversion of 4167 c.f.s. Annual maintenance under this plan would be nearly $650,000.

The whole matter of the nine-foot waterway was again taken up by a Senate committee which reported in 1925 in favor of such a project which, without quoting their authority, they said might be built for $5,000,000 provided a flow of 10,000 c.f.s. was permitted from Lake Michigan. The chairman of this committee was Senator McCormick of Illinois, a resident of Chicago, and a large part of the report was devoted to a defense of a large diversion of Lake Michigan water. Senator David A. Reed of Pennsylvania while not filing a minority report and concurring in the advisability of a nine-foot channel stated that he did

not agree that a diversion of 10,000 c.f.s. at Chicago was necessary for it.[3]

The benefits of a nine-foot channel from Chicago to the Gulf are hard to estimate. After reciting an impressive list of the products of the Mississippi Valley, the Senate committee asserted that "the immediate annual tonnage carried by water will exceed 20,000,000 tons;" an estimate that seems enthusiastic in view of the 7,900,000 ton traffic of the St. Lawrence Canals, the less than 3,000,000-ton traffic of the New York Barge Canal, and the 2,000,000-ton traffic of the port of Chicago. It might be added that the neighboring port of Calumet did a 12,000,000-ton business in 1925 but more than half of this was iron ore destined for neighboring mills. On the other hand might be given the surprising growth of business of the Inland Waterways Corporation line to St. Louis and the statements of the Senate committee that more than 18,000,000 tons of coal are mined annually in Illinois and used in Chicago and that the mines are less than a day's motor truck haul from the Illinois waterway; and the further fact that 200,000,000 bushels of grain are produced annually in Illinois within hauling distance of the waterway. The canal would be open from seven to eight months of the year and although the Drainage Canal unit is crossed by many bridges, these should not be a serious obstacle to barge navigation. It would seem that if this waterway can be built for $5,000,000 that it is decidedly worth trying.

In this place reference might be made to one other existing canal between Lake Michigan and the Mississippi, the Illinois and Mississippi Canal begun in 1893 and finished during the present century. It extends seventy-five miles from a point on the Illinois River thirteen miles below the Illinois and Michigan Canal outlet at La Salle to the Rock River and down that stream to its outlet and junction with the Mississippi. It is seven feet deep but its present connection with Lake Michigan involves the passage of the sixty-five miles of the Illinois and Michigan Canal with a maximum depth of 4.7 feet. Its outlet connects with a six-foot channel in the Mississippi. With the completion of the Illinois waterway from the outlet of the Drainage Canal to Utica this canal will then have a complete connection with Chicago and may serve some useful purpose. Its present traffic averages about 12,000 tons a year or about as much as eighteen average sized freight trains.

[3] Nine-Foot Channel. Report, Senate Document 995, Second Session, 68th Congress.

Another shallow ditch between the Fox River emptying into Green Bay and the Wisconsin, emptying into the Mississippi was started about forty years ago but is now of so little value that its statistics of traffic, if any, are unreported. Projected connections between the Great Lakes and the Mississippi watershed include canals from Lake Superior to the upper Mississippi and the revival of the canals across Ohio to the Ohio River or the building of new ones. These will be taken up in a later chapter on dreams and realities.

There remains one other major outlet from the Great Lakes to the sea in actual complete operation, the New York State Barge Canal extending from near Buffalo to Troy on the Hudson whose channel is used for the remaining 170 miles to the sea. Branches connect the main stem with Oswego on Lake Ontario with Lake Champlain, and thence with the St. Lawrence, and with interior lakes of New York.

This is the most outstanding canal in the United States. It is the longest; it has the longest history if the lifetime of its progenitor, the old Erie, be added to its own; its present performance and future prospects have caused bitter discussion among transportation experts; it is the enigma of inland canals whose fate will go far to determine the uses and limitations of that form of transportation.

From northern Alabama to within sight of the lower St. Lawrence Valley, the Atlantic coast is paralleled by mountain ranges. At long intervals, such as at Big Stone and Cumberland Gaps and the valleys of the Potomac, Juniata, or Delaware Rivers there are passes through the hills but all these are at considerable elevations and are narrow and tortuous. At only one point is the break in the mountain wall practically complete and that is along the valley of the Mohawk through central New York where a gap several miles wide leads from the valley of the Hudson to the "coastal plain" of Lake Ontario. The headwaters of the Mohawk are only a few miles from Oneida Lake and separated from it by a low and nearly flat divide, while from Oneida Lake to Lake Ontario or westward to Lake Erie extends a low, gently undulating plain, skirting throughout nearly its whole length the outposts of the Appalachian highlands to the south, and toward the east and north, the foothills of the Adirondacks. Through this nearly water-level pass the white pioneers penetrated from the Hudson Valley to the Great Lakes and laid the foundation for what is today perhaps the greatest single traffic artery on the continent, no part of which is ever materially higher above sea level than the waters of Lake Erie toward which it leads. It is the route of

the main line of the New York Central Railroad, of the principal motor highway from the west to New England, and of the Barge Canal.

The early history of the Erie Canal along this route has been already referred to and its part in developing not only New York State but the whole Lake Region has been described. George Washington visited central New York in 1783, saw its transportation possibilities, and became president of the Western Inland Navigation Company which by 1796 and at a cost of $400,000 had built six miles of canal around the rapids of the Mohawk at Little Falls. This was the first step toward the Erie Canal which was authorized in 1817 and completed from Buffalo to the Hudson in 1825. It was then four feet deep, twenty-six feet wide at the bottom, forty feet wide at the top and with locks ninety by fourteen feet. It was a prodigious success and was progressively enlarged until in 1862 it had a depth of seven feet, a surface width of seventy feet, and locks of suitable size. Traffic on the canal and its branches to Oswego and to Lake Champlain and to the smaller lakes of central New York had by that time increased to more than 4,500,000 tons annually, as compared with freight traffic on the New York Central Railroad of 1,275,000 tons in 1865. But the railroad was to prove a formidable competitor. Its tonnage exceeded that of the canal for the first time in 1875 and traffic on the waterway began an irregular decline. All tolls on the canal were abolished January 1, 1883, but this sufficed to stop but temporarily the decline of tonnage which had reached the high mark of all time in 1872 when it amounted to 6,673,370 tons. In 1885 the figure had fallen to 4,731,000 tons while the New York Central was carrying 10,700,000 tons. When in 1895, canal business had further declined to 3,500,000 tons and the railroad increased its traffic to 19,000,000 tons,[4] the state legislature decided that something more must be done if the waterway were to be of any use. Deepening to nine feet was authorized and then in 1903 the people of the state approved a bond issue of $101,000,000 which made possible the beginning of the present Barge Canal. Further referenda in 1909, 1911, and 1915 approved expenditures of $7,000,000 for connecting Cayuga and Seneca lakes, $19,800,000 for terminals, and $27,000,000 for further completion of the whole system. The total cost up to 1925 was estimated in figures contained in a message from Governor Smith to the State legislature at approximately $170,000,000. An estimate by the United States Army engineers investigating the proposed Lakes to Hudson ship canal project and made

[4] *Inland Water Transportation in the United States.*

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Upper: Fleet of Canal Boats Entering Erie Canal at Waterford

Courtesy New York State Department of Public Works

Lower: Diesel Motorship, One of the Largest Operating on New York State Canals

Length 259 feet, beam 42 feet, capacity 2000 tons. Carries general merchandise. Equipped to carry meats and perishable articles, as boat is equipped with modern refrigeration system.

public in 1926 gives the total cost including that of the original Erie at $230,000,000.[5]

The Barge Canal as completed and opened in 1918 follows for the most part the route of the old Erie, the only material deviation being that the main line is diverted west of Utica to and through Oneida Lake and thence by way of the Oswego and Seneca Rivers instead of skirting the Appalachian plateau and traversing the city of Syracuse which is now reached by a branch from the Seneca River and across Onondaga Lake to a point within the city limits. The main line is approximately 353 miles from Buffalo to the Hudson, leaving the Niagara River at Tonawanda and entering the Hudson at Waterford, near Troy, and 153 miles from New York, making the total length of the waterway from Lake Erie to the metropolis 506 miles. Branch lines extend from near Oneida Lake to Oswego, twenty-four miles; from Waterford to Lake Champlain, sixty-three miles, and from the main line to the outlets of Seneca and Cayuga Lakes, giving a total length of navigation thereon of ninety-three miles. The economic importance of the route of the canal system may be realized from the fact that within five miles of it on either side and including all its saltwater terminals, live more than three out of every four dwellers in the state of New York, the greatest in population and wealth of the entire Union.

Throughout the whole system the least projected depth is twelve feet with a bottom width from seventy-five to 200 feet. Locks are 310 by forty-five feet with twelve feet of water over the sills. On the main canal there are thirty-four lift locks with a total lockage of 664 feet. There are seven locks on the Oswego branch, eleven on the Champlain, and four on the Cayuga and Seneca.

The canal is crossed by hundreds of bridges. Some of these are drawbridges but the great majority are fixed with a minimum elevation above normal highwater of 15½ feet.

The main waterway from the Niagara River to New York may be divided into three sections. The first hundred miles or so from Tonawanda is for the most part a strictly artificial canal and it is here that the narrowest widths are most frequently found. From the junction with the Clyde River to Waterford, the waterway is chiefly a canalized river channel, using the courses of the Clyde, Seneca, Oswego and Mohawk Rivers and with a twenty-five-mile stretch of practically open navigation

[5] Waterway, Great Lakes-Hudson, House Document 288, First Session, 69th Congress, page 27.

across Oneida Lake. From Waterford to New York it follows the open channel of the Hudson. From Lake Erie to near Syracuse the canal is downgrade, descending about 200 feet in all. It then rises about fifty feet to the divide between the Oneida Lake and Mohawk watersheds and from there descends a little more than 400 feet in its passage through the Mohawk valley to the Hudson.

During the period of construction, interference with traffic on the old Erie caused a further falling off of business which amounted in 1916 to only 1,625,000 tons. The new canal, not wholly completed, was opened in 1918. The war was in progress and the new waterway was placed under federal control and a federal barge line placed in operation. The traffic that year on the whole system was approximately 1,100,000 tons of which 667,000 tons was on the Erie or main line section. Federal control was ended soon after the war and the canal system is now operated by the state of New York. No tolls are charged. There are no towpaths and the canal is therefore limited to the use of self-propelled vessels or tows propelled by them.

Traffic on the canal has steadily but slowly increased since its opening and amounted in 1926 to 2,369,000 tons. This is however only a little more than eleven per cent of the waterway's estimated capacity of 20,000,000 tons, and the reasons for this vast disproportion between possible and actual use lie so concealed among facts, opinions, and prejudices as to be practically undiscoverable even by those who know the canal best. The truth seems most accessible if the canal is considered as still in the experimental stage for after ten seasons of increasing use there has been no definite crystallization of expert opinion as to the types of boats best suited to it or the best methods of operation.

During the season of 1926 there were 846 boats in commercial service on the Barge Canal. Of these seventy-five were tow boats not carrying any cargo. Of the remainder, forty-eight were self-propelled. These included fourteen motor ships of from 1800 to 2600 tons. Towed barges varied in size from 150 to 1200 tons the greater number being of 500 tons or less. Steel was the construction material of 111 vessels, the others being built of wood. Concrete barges were tried out during the war and after under federal auspices but proved unseaworthy, unsafe, and unmanageable. Of the self-propelled vessels, steam was the source of power of twenty-seven, oil or gasoline of the others. Comparing the speed of transit with that obtaining on railroads the report of the state commissioner of canals for 1926 states that during that year the average canal

boat made 29.6 miles a day as compared with 32.6 miles for the average freight car while on the Erie division of the canal the daily movement was 33.2 miles. In the same report the average canal boat load is given at 517 tons as compared with an average freight train load of 796 tons.

Four commodities furnish nearly three-fourths the total tonnage. These in their order of precedence in 1926, were, grain, 828,000 tons; sand, stone and gravel, 332,000 tons; petroleum and other oils, 325,000 tons; and sulphur, 208,000 tons. The grain movement from Buffalo was more than 800,000 tons, the amount entering from Oswego being so small as to be negligible. Manufactured articles other than petroleum products furnished 361,000 tons of cargo, of which iron and other metals, salt, sugar, paper, chemicals, and brick were the larger items. There were 96,000 tons of lumber transported and 53,000 tons of coal, nearly all anthracite. General merchandise moved amounted to only 29,135 tons. There has generally been an increase in westbound traffic for the past seven years. This has been due to local traffic from New York and Albany, especially in petroleum products, the traffic in that commodity being one of the most significant features of the canal. In fact during 1926, westbound tonnage on the Erie division exceeded eastbound by 14,000 tons; but when through traffic only is compared the results are very different, the eastward traffic exceeding the westward by over 440,000 tons. The greater balancing of local traffic has resulted in a lowered proportion of empty to loaded boats which fell from sixty-three per cent in 1921 to forty-two per cent in 1926.[6]

This outline of the business of the waterway indicates that its use is chiefly for the transport of bulk commodities; grain through to seaboard; petroleum products from refineries to local points, sulphur through from seaboard to the Great Lakes, sand from the seacoast to local points and lumber from New York. Much of this lumber is from Pacific coast points, shipped via the Panama Canal to New York and thence by canal to interior cities. The petroleum traffic is also of interest, having developed greatly in the past few years. It is almost wholly in the hands of the Standard Oil Company which is now using the canal to transport in big motor ships or tank barges gasoline and kerosene to central distributing points along the canal.

Yet with all this diversity of traffic which increases year by year, the canal is more than seven-eighths unused and has profoundly disappointed

[6] All this data from *Annual Report of the Superintendent of the New York Department of Public Works*, 1926.

its promoters and advocates. It has proved a convenience to big corporations like the Standard Oil Company which are able to make good use of it but has not developed any extensive common carrier business and it has not been any material help to the midwestern farmer through the lowering of rates. True, its rates average about two-thirds the rail rates from Buffalo to New York but it has not attracted the export grain trade as it was expected it would. For example the average receipt of grain by water at Buffalo for the four years ending with 1923 was in round numbers 194,000,000 bushels. For the same period receipts at Montreal via the St. Lawrence canals averaged 64,000,000 bushels and receipts at New York via the Barge Canal, 14,000,000 bushels.[7] The most of the remaining 116,000,000 bushels went to the seaboard by rail. The St. Lawrence canals alone get more than four times the grain trade of the Barge Canal.

This proportion may be changed somewhat when after the completion of the new Welland Canal, the big lake freighters may go to Oswego before transshipping their grain but at present one cause of the preference of the grain trade for the Montreal route seems to be the superior elevator facilities at that port. The elevators there have a capacity of 11,766,000 bushels as against a total of 8,000,000 bushels for the port of New York. This difference is accentuated when it is considered that the Montreal elevators are all operated by the port as a unit while the New York elevators are mostly in railway ownership. There is a Barge Canal elevator at the port of New York and it is the main reliance in handling canal grain, but it has a capacity of only 2,000,000 bushels and a delivery capacity from elevator to ship of only 30,000 bushels an hour as compared with 300,000 bushels from the Montreal elevators.[8,9] The grain export trade at both ports is largely carried as a surplus, stop-gap cargo by liners. This gives a fairly even demand. Tramp steamers however come and go on an irregular schedule or no schedule at all and an influx of them, hungry for grain at New York harbor means a long wait for cargo compared with the celerity with which they may be loaded at Montreal which because of these excellent facilities has attracted a large tramp trade in grain. These elevator facilities also reduce the wait of barges and steamers before unloading which in New York often causes serious delay. It was probably due in part to these causes that the two

[7] *Transportation on the Great Lakes*, pages 124–144.
[8] *Transportation on the Great Lakes*, pages 124–144.
[9] Ritter, page 231.

1700 ton motor ships which went into service in 1924 carrying grain from Duluth to New York were later transferred to the St. Lawrence route.

The lack of use of the Barge Canal by common carriers is probably due in part to general reasons against canal traffic and in part to special reasons incident to modern business practice. Hand to mouth buying is increasingly common, merchants keep small stocks on hand and rely upon speedy deliveries from the manufacturers. This means rail or motor delivery. The latter has the additional feature of eliminating trucking charges. It stands to reason that no merchant is going to choose a method of shipment which requires transfer from boat to rail and then to motor if he can for even a slight additional cost have direct delivery from factory to warehouse or store.

But a more fundamental difficulty is the lack of traffic agreements with the railroads such as have been so essential a factor in the success of the Inland Waterways Corporation on the Mississippi. As will be seen later, no waterway, unless its length approaches 1000 miles, can compete with through rail common carrier rates if it has been compelled to secure its traffic from and to deliver it to railroads with which it has no arrangement looking toward the mutual sharing of a lowered through rate. Coal for example is sent by rail from the Pennsylvania or West Virginia mines to Lake Erie ports and transferred to rail again at Duluth; but Chicago, which has mines about 250 miles distant by rail, receives practically no coal by lake, nor does any but a small portion of eastern Canadian shipments travel on the lakes except to cross them in car ferries.[10]

For this reason, the traffic on the Barge Canal is very largely limited to traffic between the cities through which it passes and to goods received from or transferred to lake vessels with which through rates are in effect. Practically all the through shipments beyond Buffalo go this way and it is noticeable that while in the report of the superintendent of the canal for 1926 there are many instances given of through canal-lake-rail routes, the rail section is nowhere east of Chicago where through rates to New York are evidently low enough to compensate for the cost of transfer from car to canal boat.

Another drawback to the canal is that it is closed by ice for about five months of the year. Shippers are no different from all men in that they are creatures of routine and of habit and unless they are in a position to make seasonal deliveries and store goods for long periods they are not going to favor one method of transport for one part of the year and

[10] *Transportation on the Great Lakes*, "The Coal Movement."

another for the rest of it. The railroad is always there. This is a drawback but not a fatal one and it is made too much of in the report of Colonel Frederick S. Greene, Superintendent of Public Works of the State of New York, to Governor Smith in 1926. This was a special report, covering the relative merits of the Barge Canal and the proposed St. Lawrence ship channel and devoting much space to an inquiry as to why the present canal was not more used. Colonel Greene gives the closing of the Barge Canal by ice as the main reason why the canal is not more used and states that if it were open throughout the year it would be crowded with traffic. This ignores the fact that the navigation channels of the Great Lakes are blocked by ice for an equal period but are used almost to their capacity for seven months, that the same is true of the present St. Lawrence Canals and of the ports of Montreal and Quebec which manage to survive the handicap of severe winters.

Colonel Greene's reasoning is superficial. Ice is a factor but only because no type of boat has yet been devised or put into extensive use on the Barge Canal which by reason of adaptation to local conditions can carry freight at such small cost as to earn a year's profit in seven months, or which by reason of construction may be used during the off season in coastwise trade. The first of these conditions is met by the lake freighter, the last by the ocean shipping which uses Montreal. The lake freighter has been evolved to meet unique conditions. It can not be profitably operated at sea but it can handle its own job so easily and so cheaply that it can earn enough in seven months to pay interest and overhead for twelve. The ocean shipping that uses Montreal is dispersed during the Canadian winter to the trade routes of all the world. But the typical canal barge is not such a profitable and efficient device as to be able to earn a year's living in seven months or at least not a very fat living, not enough to encourage the building of more boats of that type; nor can it be used during the winter on any other type of waterway. The solution of the problem is indicated by the practice of the Standard Oil Company which has devised a type of tanker which can be used on the canal in summer and on coastwise service in winter.

Other technical difficulties such as low fixed bridges, stoppage of traffic from slides, faults in organization, political control, all contribute to the hesitancy of capital to invest in canal shipping; but the main cause for the lack of use of the waterway seems to be the present lack of a type of boat which can be operated there with reasonably certain profit in common carrier business. As pointed out in the last paragraph, the

Standard Oil Company has found a solution of this difficulty with respect to the carriage of its own products, and its solution points toward another factor which is needed to make any waterway of the canal type a financial success. The oil tankers go into coastwise trade in winter but it is a business of some risk for they are not wholly able to operate on inland coastal routes. If, on the other hand, there were an inland or sheltered waterway paralleling the coast from Boston to Florida, vessels which used the northern canals in summer might be transferred to southern service in winter and earn profits throughout the year. An Atlantic coastal waterway is an essential and integral part of any national system of inland waterways.

The report of the New York State Superintendent of Public Works for the year 1927 shows a continued increase in traffic on the State Barge Canal System. The total traffic that year was 2,581,892 tons, the largest in the history of the new canal and an increase of nearly nine per cent over the preceding year which itself was a record one. The increased tonnage was principally in sugar, petroleum, sand, stone, and gravel, iron and other metals, ores other than iron, coal, and general merchandise. Decreased tonnage was shown in sulphur, lumber, salt, and grain, although in the last classification the loss was not in wheat of which 71,000 more tons were carried than in the preceding year.

The report shows a continuation of the trend toward more westbound local traffic, especially in petroleum products. Significant developments include a successful voyage of an oil tanker from Philadelphia to Montreal via the Hudson River, the canal to Oswego, and thence via Lake Ontario and the St. Lawrence; increased shipments of copper from New York to Rome and Buffalo; and most important of all, larger through shipments to and from Lake ports. Pig iron has been shipped directly from Cleveland to Long Island Sound ports and a direct service between Detroit and New York via the Welland Canal and Oswego, carried a large tonnage of grain and automobiles east, and of sugar, canned goods and miscellaneous freight west.

A notable development was also the increase of 173 per cent in the traffic through Oswego. This shows an increasing preference toward the use of deep lake channels that will be more marked on the completion of the new Welland Canal and has an enlightening bearing on the present preference of grain shippers for the St. Lawrence over the New York route, a preference having important bearing on the relative advantages of the ship canal routes.

See note A, page 186.

CHAPTER XI

Atlantic Coastal Waterways

From southern Maine to Florida and thence to the Mexican boundary, the coast of North America is a gently sloping plain. Throughout this whole distance of about 3500 miles the immediate coastline is almost everywhere low and sandy with few elevations above 100 feet and none of them south of the shores of New York Bay. On the Atlantic side the littoral rises slowly toward the interior until at a distance varying from nothing at the northern extreme to a few hundred miles in the south it meets the foothills of the Appalachian system. No part of Florida is more than a few hundred feet above the sea and from the western boundary of that state along the Gulf of Mexico to the Rio Grande the coastal plain merges imperceptibly into that of the Mississippi Valley or into the rolling prairies to the west. Back of the whole shore line from Massachusetts to Mexico there lie at varying distances for nearly its whole extent a succession of sounds, bays, rivers, swampy bayous and a few natural channels which have so far been joined by artificial channels or canals as to form an inland waterway for most of the distance between Boston and Key West. To unite all of these unconnected links so as to form a continuous inside channel at least twelve feet deep from Boston to the Rio Grande is the ultimate aim of the extreme advocates of the Atlantic Intracoastal Waterway.

The route of this waterway is studded with great cities, and at several points, notably New York and New Orleans, passes the sea outlets of great systems of inland navigation. A vast volume of commerce is already carried by water between all these cities, most of it on the open sea, a great deal on separate links of the coastal waterway on which an increasing volume of traffic testifies to the need of a more sheltered channel for light draft craft. The gross coastwise tonnage of the Atlantic coast ports amounted in 1926 to 109,000,000 tons as compared to a total foreign commerce of 72,000,000 tons. These figures are somewhat misleading for the coastwise traffic includes that to Pacific coast ports and most of the remainder is counted both at the port of shipment and port of receipt while the foreign tonnage is counted but once. But even if the tonnage figures for the coastal shipping be halved they will be

seen to be comparable with the whole of the combined exports and imports. Every large Atlantic and Gulf coast port except Baltimore and New Orleans, did a bigger coastwise than foreign business in 1926. Evidently there is traffic enough now moving by water to supply adequate tonnage to an adequate waterway to say nothing of tonnage that might be attracted from the railroads. Some of this water borne coastal trade now moves through the natural and artificial channels behind the protecting islands and sand spits of the coast.

These natural links in the chain are Long Island Sound, New York harbor and connecting channels, the Delaware River, Chesapeake Bay, and the sounds of North Carolina. The artificial links are the Cape Cod Canal, connecting the relatively protected waters of Massachusetts Bay with the approaches to Long Island Sound; the Delaware and Raritan Canal, connecting New York harbor by way of the Raritan River with the Delaware River; the Chesapeake and Delaware Canal joining Delaware Bay with Chesapeake Bay, and a series of canals and channels joining Chesapeake Bay and the Carolina sounds. Although the depth of these natural and artificial channels is twelve feet or more for the greater part of the distance from Boston to Beaufort, North Carolina, the limiting depth is seven feet in the Delaware and Raritan Canal. Vessels of twenty-two feet draft may now pass by the inside route from Boston to the mouth of the Raritan in lower New York Bay, and boats of eight feet draft can safely navigate at low water all the channels from Philadelphia to Beaufort.

From Beaufort to Florida the inside route is far from complete. A gap of more than 100 miles exists from a little beyond Beaufort to the mouth of the Cape Fear River, up which Wilmington is situated. Boats drawing as little as three feet can, with expert pilotage, pass through inside channels from Beaufort to New River inlet, thirty-five miles; but any vessel drawing more than four feet must take to the open sea for fifty-five or sixty miles to get to the entrance of Cape Fear River. Many craft find it better to take a wide sea course from Beaufort, making the distance 108 miles. Beyond Cape Fear there is another stretch of outside navigation for seventy-three miles to Winyah Bay or Georgetown harbor from which inside route channels with depths in places as little as three feet at low water continue all the way to the St. Johns River in Florida. The shallowest reach is between Georgetown and Charleston, South Carolina, seventy miles, beyond which the low water depths are generally more than six feet. All these channels from Winyah Bay southwards are

natural channels lying back of the sea-islands that fringe the coast. They are dredged in places and for short distances but not canalized and boats passing through must exercise caution and take advantage of the tide. From the St. Johns River to Miami there is a continuous inside channel, much of it through canals, with a least depth of four feet, although seven feet obtains over much of the distance of 310 miles. From Miami the channel is partially though quite effectively protected by outer reefs or islands for the remaining 136 miles to Key West, the least depth in this section being about ten feet.

Summing up, it is found that of the total distance of approximately 1700 miles from Boston to Key West by the coastal waterway, about 200 miles is outside navigation across Massachusetts Bay, and the entrance to Long Island Sound and off the Carolina coast. The 770 mile stretch from Boston to Beaufort, North Carolina, is all available for boats drawing eleven feet except for the fifty miles of the Raritan River and Delaware and Raritan Canal. South of Beaufort, a depth above six feet is unusual.

There are four great natural links in the Atlantic coastal waterway, Long Island Sound, Chesapeake Bay, the Delaware River below Philadelphia, and the sounds of North Carolina. All of these but the last have channels of at least thirty-foot depth while the northern extremity of the route from Boston to Cape Cod is through the deep, only partially protected waters of Massachusetts Bay. The first steps toward the construction of a continuous coastwise channel were naturally the connection of these existing channels by artificial canals.

The first of these to be projected and one of the last to be built was the Cape Cod Canal, joining Massachusetts Bay with Buzzards Bay, an estuary of Long Island Sound, and making possible a route from Boston to New York sixty-six miles shorter than the one outside Cape Cod and, unlike it, exposed to the full fury of the north Atlantic for only a few miles. Miles Standish thought about it in 1623, an official investigation was made in 1697 and in 1776 George Washington advocated it as a military measure. A detailed report was made to the state legislature in 1862 and in 1883 a private company began work on a canal, ceasing it after $1,500,000 had been sunk. After about twenty-five years another company was organized, began work in 1909 and opened the canal in 1914 since when it has been in practically continuous operation. Federal ownership was urged soon after the canal was opened and finally was authorized by Congress in 1925, the price agreed upon being approximately $11,500,000.

The Cape Cod Canal extends across the isthmus of Cape Cod from a point fifty-five statute miles south of Boston harbor to the northerly extremity of Buzzards Bay, 201 miles east of New York. It is a sea-level canal without locks and is a little more than $7\frac{1}{2}$ miles long. The dredged approaches in Cape Cod Bay and in Buzzards Bay give a total length, however, to the artificial channel of thirteen miles. The canal as originally constructed was not navigable for vessels of more than twenty feet draft and had a bottom width of only 100 feet for most of its length, so that for large craft it was practically a one-way canal. It is now twenty-five feet deep at low water but the width is unchanged. The canal is crossed by one railroad and two highway bridges, all being drawbridges of the double bascule type.

Traffic through the canal increased fairly steadily from its opening until 1919 when 2,908,000 tons of cargo freight were transported through it. Since then there has been a decline, the tonnage amounting in 1925 to only 661,456 tons but increasing in 1926 to 840,000 tons. Passenger traffic has however shown a quite steady increase, the maximum number of passengers, 166,787, having been carried through the waterway in 1926. The route is used by some of the large passenger boats plying between New York and Boston as it makes possible a continuous water trip beween the cities in only a couple of hours or so longer time than is required for a boat and rail journey via Providence or Fall River. The decline of freight traffic has been due to the narrowness of the canal and the tidal currents through it, which have caused several accidents resulting in the loss or injury of vessels. In spite of the fact that it saves coastwise shipping from many of the dangers from storm or fog incident to a voyage around the Cape, 11,943 vessels took the longer route in 1925 as compared with 5010 which used the canal, and of these 5000 more than twenty per cent were yachts.[1] The reason seems to be that shipping prefers sea-room to narrow channels, especially when it has to pay to pass through the latter as it had to do under private ownership of the Cape Cod Canal. Deepening and straightening of the canal and the abolition of tolls under federal ownership may be expected to increase traffic materially. The period of greatest traffic was during the war when the waterway was under federal control but this was due largely to the submarine menace which, in July, 1918, became a reality, a number of vessels being then sunk off Cape Cod and in Nantucket Sound by the German submarine U-53.

[1] *Commercial Statistics of the United States*, 1925.

The first important link of the Atlantic coastal waterway was the Chesapeake and Delaware Canal, now, after a long and useful life and recent purchase by the federal government, about to enter its second century of existence. It was advocated as a military measure soon after the war of 1812 when the British capture of Washington was felt to have been largely due to poor communication and the resultant inability of the American commanders quickly to concentrate their forces. The British blockade also paralyzed American coastwise trade. The canal was begun in 1824 and opened in 1829. Its cost was $2,500,000 of which $450,000 was contributed by the government of the United States. Other subscriptions to the stock of the canal company were made by the states of Maryland, Pennsylvania and Delaware.

The canal as originally built was 13½ miles long, extending from Delaware City on the Delaware River, forty-two miles south of Philadelphia to Back Creek, one of the northern extremities of Chesapeake Bay, fifty-six miles north of Baltimore. Nearly all the canal is in Delaware, the westernmost mile of the channel being in Maryland. Originally a shallow ditch it had been enlarged during the nineteenth century to a depth of nine feet with three locks twenty-four feet wide and 220 feet long. In 1925 it carried 727,000 tons of freight and was unique among all our inland waterways in that general merchandise was the largest single item. Lumber, petroleum products, chemicals, fertilizer, sugar, coal and cinders were other important articles of its commerce. The canal justified itself from a military standpoint during the Civil War when for a period of some weeks after Confederate sympathizers had burned all the railway bridges between Baltimore and the Susquehanna River, at the very outbreak of the conflict, it was the only direct transportation route between Washington and Philadelphia. It was used by the first reinforcements which saved Washington for the Union and all through the war it was an auxiliary transportation route of great importance.

The canal was purchased by the federal government from the original canal company in 1921 for $2,514,290 and was enlarged and rebuilt as a sea-level waterway, the work having been sufficiently completed to permit the channel to be open to traffic in the spring of 1927. It has now a depth of twelve feet and a bottom width of ninety, permitting the passage of the largest type of inland barges and of coastwise steamers of moderate size. Anticipating eventual deepening of the canal to thirty feet and the passage through it of ocean shipping, all of the six bridges

which cross it are of the movable type. One is a swing bridge, the others lift bridges with vertical lifts of 135 feet. The canal is crossed by five highways and one railway. Some difficulty was caused by tidal currents after the recent reconstruction but vessels of twelve feet draft can get through by watching the tide, and barges may be safely towed if sufficiently powerful tugs be employed. Shoaling due to currents and to slides is controlled by dredging.

The link in the coastal waterway between New York and Philadelphia also was built early in the last century but, unlike the Chesapeake and Delaware Canal, the Delaware and Raritan has never been modernized and is to-day the weakest link in all the chain of channels and waterways north of Beaufort, North Carolina. It is forty-four miles long, extending from New Brunswick on the Raritan River, ten miles above New York lower bay to Bordentown on the Delaware River 26 miles above Philadelphia. It is wholly within the state of New Jersey. The channel is seven feet deep and the same depth is found in the Raritan and in the Delaware for short distances beyond the canal outlets. There are thirteen locks and the canal is crossed by twenty-four bridges, all of them movable except the Pennsylvania Railroad bridge at New Brunswick which has a clearance of fifty feet.

The Delaware and Raritan Canal was built during the period of the canal fever in the early nineteenth century and was opened for traffic in 1834. After a number of financial adventures and consolidations, the property came under control in 1871 of the Pennsylvania Railroad Company which operates it under a 999-year lease. Since it passed to railroad management it has suffered a progressive decline in traffic which in 1925 amounted to only 147,000 tons, mostly coal, as compared with 2,800,000 tons in 1872. In its present state it is a dying canal and would probably be suffered to pass quite away were it not an essential link in the coastal waterway system. Unless inland water transportation is demonstrated to be an idle and costly folly, the old Delaware and Raritan is destined eventually to be superseded by an entirely new canal, possibly of ship canal proportions, between New York Bay and the Delaware River.

This would extend from near Morgan, New Jersey, on Raritan Bay, an estuary of lower New York harbor, across central New Jersey to Bordentown on the Delaware a distance of thirty-four miles. It would make the total distance from New York to Philadelphia by the way of the channels around Staten Island, the canal and the Delaware, eighty-

seven miles. As an engineering possibility it presents no great obstacles, so few in fact that a sea-level canal is practicable, although more expensive than one with locks. A special board of United States Army engineers reported in 1911 in favor of the building of a sea-level canal, twenty-five feet deep, along this route at a cost of $45,000,000, provided a right of way be ceded by the state of New Jersey. This the state has agreed to do and has even put up marking monuments along the center line of the proposed canal route. This special report was not concurred in by the army board of engineers and by the Chief of Engineers, General W. H. Bixby, who favored a lock canal, twelve feet deep, at a cost of $12,000,000. These estimates are pre-war and of little value at present; but all reports agree on the feasibility of a canal over this route. There is no elevation along it materially greater than 100 feet, it avoids the main lines of railroad and the more populated sections and encounters no rock formation anywhere. A lock canal would require only two lift locks to raise boats to the summit level of seventy feet above tidewater; by a sea-level canal the engineers estimated the time of the voyage of an ordinary ocean freighter from New York to Philadelphia would be shortened from twenty hours to eight and that such a canal passage would avoid great dangers and delays off the New Jersey coast. As for the potential traffic, it was estimated in 1910 that 53,000,000 tons were carried by rail between Philadelphia and New York every year. No further action has been taken by Congress and the matter stands with the project approved as feasible and New Jersey ready to acquire and cede the right of way. The completion of a twelve-foot canal would give an inside route of that minimum depth from the entrance of Long Island Sound, practically from Boston, to Beaufort, North Carolina. A twenty-five-foot channel across New Jersey and another along the route of the Chesapeake and Delaware Canal with deepening of the Delaware River would provide an inside channel from Boston to Norfolk for seventy-five per cent of all ocean shipping.[2]

Such a channel would have military advantages even more manifest than its commercial uses. If our Atlantic coast were ever again blockaded as it has been in the past, the ability to move submarines and better yet, capital ships over such an inside route is too obvious to require much discussion. During the World War the bulk of the Atlantic fleet was kept in York River, a tributary of Chesapeake Bay. A blockade

[2] New Jersey Intracoastal Waterway, Senate Document 18, First Session, 65th Congress.

of the entrance of the Bay would have put our battle fleet into the relatively impotent position of Germany's. Even a good barge canal would be of great assistance in times of railroad traffic congestion such as have been known to exist in war time.

At Norfolk any possible deep coastal waterway ends. From that point southwards the construction of any channel deeper than twelve feet is out of the question economically since it would involve dredging or canal building for practically the entire distance. Present channels are now approximately twelve feet deep for 100 of the 128 miles from Norfolk to Beaufort by way of the Albemarle and Chesapeake Canal, now owned by the federal government, and Albemarle and Pamlico Sounds. The Albemarle and Chesapeake Canal is seven miles long, connecting the south branch of the Elizabeth River below Norfolk with North Landing River which after a course of ten miles flows into Albemarle Sound. It is at sea-level, without locks, crossed by four drawbridges, and free of tolls. There is an alternative route from Norfolk south by way of the Dismal Swamp Canal which traverses the swamp and is connected with Lake Drummond in its center. This canal is in private ownership, tolls are charged. It is nineteen miles long, has two locks, and a depth of about ten feet.

Albemarle and Pamlico Sounds are big bodies of water but they are shallow. Together they provide more than 150 miles of the inside route but in places the channel must be dredged to maintain a depth of twelve feet. In the widest and deepest part of Pamlico Sound where it is at least a dozen miles either to the mainland or to the outlying bars which divide the sound from the sea, the depth does not exceed twenty-five feet.

These waterways from Norfolk to Beaufort carry a considerable commerce, largely lumber or rafted logs, but including also a large tonnage of vegetable products. The traffic on the Albemarle and Chesapeake route in 1926 amounted to 641,000 tons not including 36,000 tons of rafted lumber. That on the Dismal Swamp route amounted to 218,000 tons not including 51,000 tons of rafted forest products. The former waterway carried that year 96,000 tons of fertilizer material to farmers along its route and carried over 54,000 tons of fruits and vegetables and 4600 tons of cotton, besides more than 3000 tons of seafood products. It carried 32,000 tons of gasoline and kerosene and 8800 tons of coal and did a fairly large trade in general merchandise. If to this be added the traffic of the Dismal Swamp Canal it will be seen that these inland water

routes are among the most important in the country. They serve an area that is rapidly growing to be one of the chief vegetable producing regions of the east and provide for it an outlet for its products of field and forest and sea that means lower prices for the consumers in the great industrial cities of the north and higher prices for the producers in this land that not many years ago was considered almost worthless save for its forests.

South of Beaufort, North Carolina, the Inland Coastal Waterway is more of a dream than a reality. To realize the dream will cost millions of money. New channels must be dredged for more than 150 miles between Beaufort and Georgetown, and beyond that point existing ones must be deepened. A channel twelve feet deep from Beaufort to Wilmington, North Carolina, on the Cape Fear River was authorized and begun in 1927. Army engineers estimated in 1913 that it would cost $31,000,000 to build a ten-foot channel from Beaufort to Key West, an estimate which present costs would probably raise to $50,000,000. This route would closely follow existing routes which have already been described, except for the wholly new construction between Beaufort and Georgetown, at the head of Winyah Bay. The present tonnage of the unconnected and shallow completed sections of this waterway between Beaufort and Jacksonville, Florida, would seem to encourage a large expenditure as it amounted to 512,000 tons in 1926.

After Florida is reached, traffic on the coastal waterway shows a decided decrease. The traffic of the Florida East Coast Canal, including the Indian River and comprising the entire waterway between Jacksonville and Miami, amounted in 1926 to 262,000 tons.[3] Practically none of this though was general merchandise or agricultural products; the bulk was stone and sand. The shallowness of the channel is reflected in the type of boats which used it; of more than 20,000 commercial craft that used it in 1925 only 566 were above five tons burden. In addition the canal was used that year by 2328 yachts. Army engineers estimated in 1926 that an eight-foot channel might be built from Jacksonville to Miami at a cost of $4,221,000 and local commercial interests estimate that such a channel would attract 1,500,000 tons of freight at an annual saving in transportation costs of $1,670,000. From the experience of the Albemarle and Chesapeake Canal on which traffic increased nearly four-fold in the five years after the channel was deepened it would seem that a deeper Florida coastal canal would attract much more freight than at

[3] During the "boom year" of 1925 it amounted to 700,000 tons.

present, particularly since it goes through a developing area of considerable productive capacity.

Westward of Florida there is no adequate coastal waterway. Canals and channels lead from the "back door" of New Orleans along the Mississippi and Alabama coast to Mobile Bay but there is a long gap from that point to Key West. It has been suggested to bridge this gap in part by a canal across Florida, and United States Army engineers have reported that such a canal might be constructed from the St. Johns River by way of a series of lakes and rivers to the outlet of the Withlacoochee River into the Gulf of Mexico. The total distance from Atlantic to Gulf would be 237 miles of which 105 miles would be through existing channels of the St. Johns River. Fifteen locks would be required and the estimated cost in 1924 was $16,500,000 for a channel twelve feet deep. The project was disapproved by the engineers who agreed that it would attract only local traffic since through traffic to Gulf ports would prefer to make the trip without change around Florida in ocean going vessels. The amount of prospective local business was felt to be insufficient to warrant the expense of construction.

Westward of Mobile Bay the present coastal channel is an important link in the waterway from New Orleans to Mobile and thence up the Tombigbee and Warrior Rivers to Birmingport, near Birmingham, Alabama. This route is used by the Warrior division of the Inland Waterways Corporation which in 1926 carried over it more than 296,000 tons of freight. More than twice this tonnage was carried through the coastal channel by all carriers. It has a controlling depth of about nine feet with greater depths in many sections.

Westward and southwestward from New Orleans to the Mexican boundary stretches the last link of the coastal waterway. From the point of construction it is a rather weak link as the controlling depth is only five feet and it suffers in many places from shoaling, but from the point of view of use it is important. Rail facilities in southern Louisiana are meager and the present shallow and narrow ditches that connect with the Mississippi at New Orleans carry nearly 200,000 tons of freight annually. A continuous waterway with five-foot depth extends the whole 290 miles of the Louisiana coast, the route being through the nearly level, swampy land from five to fifty miles back from the Gulf. The land is rich and fertile. In Texas a little more than two-thirds of the 295 miles of coast from the state to the national boundary is paralleled by a waterway with a depth of five feet or more. Except as before mentioned

in Louisiana, these waterways are little used although the potential traffic is large.

The waterway program approved by the United States Army engineers and adopted by Congress provides for a channel nine feet deep and 100 feet wide for the entire distance. The estimated cost in 1924 was $15,943,000,[4] which seems cheap for 585 miles of waterway. The tonnage possibilities have been placed as high as 12,000,000 annually by no less an authority than General G. W. Goethals who acted as consulting engineer to the board of army engineers who investigated the route.[5] His report dated November 27, 1923, states that in his opinion this tonnage will result from the completion of the canal as an integral part of the Mississippi and Ohio River developments and with the enlargement of the Chicago-Mississippi Canal upon all of which it is dependent. The larger part of this commerce is expected to be in sugar, salt, oil, sulphur, and lumber; all of which are products of the region.

Such is a general survey of the costs and possibilities of an Atlantic and Gulf waterway. The name is slightly misleading for even the present estimates leave a big gap between Florida and Mobile; but they provide for a channel at least eight feet deep from Boston to Miami with greater depths in the more important sections; and they include a nine-foot waterway linking the Mississippi and Warrior River systems with the Louisiana and Texas coasts. Owing to changing prices since many of the estimates were made they are not accurate at the present time but they may be used as a guide, and it seems a fair guess to put the cost of such a program, including a twelve-foot channel across New Jersey, at about $100,000,000.

Such a system would link up with the Mississippi system and with the Great Lakes at New Orleans. It would connect with many smaller river systems throughout its course and again at New York it would through the Barge Canal and possibly through a ship canal, link with the Great Lakes system. It might perhaps be better said that it would make the latter connection at Albany, for the federal government has approved the deepening of the Hudson channel to twenty-seven feet at that city, 150 miles from the sea. This is not so much of a job as it seems as with the exception of one twenty-five-foot shoal a depth of twenty-seven feet extends to within thirty-five miles of Albany, above which the least depth is about twelve feet. Here at Albany will be a point of contact

[4] House Document 238, First Session, 68th Congress.

[5] House Document 238, First Session, 68th Congress, pages 97–102.

between the coastwise, the ocean, and the inland systems of navigation so that from the end of Lake Erie the Great Lakes will have water contact with the Atlantic coast and from the head of Lake Michigan they will have a direct waterway down the Mississippi and along the Gulf Coast, uniting in water communication the most important industrial and agricultural sections of the Union.

That is the big idea of inland waterways. It is an idea that has been too big for some who have played with it. They have not merely dreamed dreams and seen visions but they have dreamed very visionary and impractical dreams which they have urged with some vehemence.[6] Other visions are possibilities of perhaps the not distant though not immediate future. They will be briefly considered in the next chapter.

[6] The authorities for most of the statements in this chapter are the Reports of the Chief of Engineers for 1926 and 1927; *The Inside Route Pilot*, 1922; published by the Coast and Geodetic Survey; The Cape Cod Canal, House Document 1768, Third Session, 65th Congress; *The Cape Cod Canal*, published by the old canal company; *Atlantic Intracoastal Canals*, Department of Commerce, 1918.

CHAPTER XII

Dreams and Visions

As an engineering feat, it is quite likely that it would be possible to build a ditch thirty feet deep and a hundred feet wide from Washington to Seattle. To fill it with water would be a far more difficult task; to find boats and commerce enough for it to make it pay would be an impossible one. This extreme illustration is used to point out the two great objections to the more fanciful schemes of waterway construction. A canal is not merely a ditch; it is a ditch filled with water, a fact frequently overlooked by enthusiasts who think that the necessary element will in some miraculous way be provided. Nor is a completed canal necessarily a waterway. It must justify itself by performing a service which in all its implications no other transportation service can do as cheaply or as well. These fundamental considerations are too often neglected by promoters of waterways who seem to think there is something peculiarly sacred about that means of carriage and who advocate the construction of canals for which no economic or other justification now exists. In the future, perhaps, but not now.

Nearly all these schemes center about the Great Lakes whose immense commerce attracts all the transportation visionaries as honey draws bees. They involve the building of canals or waterways along river channels to connect the lakes with one another, with the Hudson, with the Ohio, with the Gulf of Mexico. One of the most magnificent of these visions is a sort of super-All-American Canal, uniting the waters of the Great Lakes and the Hudson. It is known as the Bowen Ship Canals from the chief promoter, Millard F. Bowen of Buffalo, who states that he proposes to raise the cost of construction privately if the federal government will grant a charter to a company for that purpose. There would be two canals, one from Lake Erie at some distance south of Buffalo to Lake Ontario following a route approximating that emphatically condemned by federal engineers. It would cut all the railways and highways entering Buffalo and require at least seventy bridges. The other canal would be from a point about twenty miles east of Oswego on Lake Ontario, connecting that lake by entirely new construction with the Barge Canal route at Oneida Lake and following from there to the Hudson

the approximate route of the All-American Canal. A detail of construction is the raising of Oneida Lake some sixteen feet. This would be an interesting performance to the inhabitants of that region as the shores of the lake, especially on the southern side, are less than that elevation above its waters for miles inland so that many square miles would be flooded, involving the relocation of railways and highways in a settled country. It is further proposed to compass the entire descent of 570 feet from Lake Erie to tidewater by means of seven locks of which the highest would be 210 feet, as compared with lifts of forty-six feet in the new Welland Canal and the three Gatun locks at Panama with a total lift of 85 feet. The enterprise, the cost of which is not clearly stated, but if the estimates for the All-American Canal be taken as a guide can not be less than $600,000,000, is expected to pay for itself through the development of 2,500,000 horsepower of which only 1,400,000 is to be developed by the waterway itself, the remainder coming from the St. Lawrence. Of this 1,400,000 horsepower, 800,000 is to result from utilization of the 326 feet fall between Lakes Erie and Ontario, an additional diversion of some 20,000 c.f.s. being depended upon to produce it. Mr. Bowen states that no new treaty with Canada would be needed in spite of the fact that the United States is now using practically its full allowance at Niagara under the present treaty.[1]

The scheme would seem to have all the faults of the All-American Canal in accentuated form. It has never received official sanction or approval; it is still a vision; it seems likely to remain so for a long time.

Another example of expensive tastes in canals is the proposed barge canal connecting Lake Erie and Lake Michigan. This would start at Toledo, follow the valley of the Maumee River upstream to Fort Wayne, Indiana, a distance of 110 miles, and thence wander overland to Lake Michigan by one of two alternative routes. The northern would be by way of Elkhart, South Bend and Michigan City and the southern by way of Huntington and Rochester, Indiana, to the neighborhood of Gary, thence by the Calumet River to Calumet harbor on Lake Michigan. The total distance from Toledo to Chicago harbor by either route would be within a mile of 281 miles. The distance by the present route through the Straits of Mackinac is 674 miles. The canal would cross the divide between the two lakes, a rolling ridge of land from 190 to 250 feet above their level, necessitating fourteen locks on the northern and nine locks on the southern route.

[1] Most of this from Mr. Bowen's own literature.

The cost of a ship canal between these points has never been closely estimated; that of the much cheaper form of barge canal was inquired into by army engineers in 1917, who figured that by either the northern or southern route the waterway would cost $135,000,000. These figures were based upon a canal practically duplicating the New York State Barge Canal, then approaching completion. The channel was to have a depth of twelve feet and a bottom depth of 110 feet, with locks forty-five feet by 338 feet, making navigation practicable for barges 300 feet long.

The engineers recommended against building any such canal on the grounds that no benefit commensurate with the cost would be attained. A railway capable of carrying the 18,000,000 tons of freight, which they estimated as the capacity of the waterway in a season of seven months, could be built for less money and could do a twelve months annual business. There is already a through water route between the terminals and the only two arguments in favor of a new channel are, first that it will save time on inter-lake voyages and will stimulate through barge traffic between Chicago and New York by the proposed canal, Lake Erie and the New York Barge Canal. A development of local traffic was conceded but that was considered insufficient to warrant construction, nor was the possible development of less than 17,000 horsepower from available waterpower considered as an offset to the expense of construction. As to the saving of time on through voyages it was pointed out that the retardation of vessel speeds through the canal would reduce the saving to less than fourteen hours between Chicago and Toledo for a vessel capable of ten statute miles per hour in the open lake. About ten hours would be saved on a voyage to Buffalo. If a boat could make as much as eleven miles per hour in the open lake nothing would be saved by a voyage through the canal while for boats of faster speeds the canal would be the slower route. For all these reasons, cost, small saving of time, existence of a through water route and of several rail routes, and their resultant inability to estimate the probable traffic on such a waterway, the army engineers decided against it. From the present experience of the New York Barge Canal their decision was wise. No active demand for such a canal is now heard.[2]

Another elaborate waterway scheme which twenty years ago attracted much support was the proposed fourteen-foot channel from Chicago to

[2] Lake Erie-Lake Michigan Waterway, House Document 343, First Session, 65th Congress.

the Gulf. "Fourteen feet through the Valley" was then the battle-cry. The proposal was the subject of an elaborate report by the indefatigable United States Army engineers who decided negatively on the general grounds that a nine-foot channel would do as well if not better. Of all depths for inland waterways that of fourteen feet is perhaps the least practical. No ocean vessel of any importance draws so little; no river barge need draw as much. The channel of the Mississippi would be always undependable in low water above Cairo or even Vicksburg if such a depth were striven for and it would be afflicted with many sharp bends that would make the safe navigation of any ocean vessel an impossibility. As we have seen, practically all of these and all lake freighters as well would be debarred from such a channel by their depth leaving it to barges which as events have shown can operate economically and successfully in depths of eight or nine feet. Furthermore it has been shown that the maintenance of even a nine foot channel in the Illinois River without the use of locks and dams is dependent upon a withdrawal from Lake Michigan through the Drainage Canal of at least 4167 c.f.s. Much more than the 8500 c.f.s. used in 1926 would be required for a fourteen-foot channel with results in the way of damage to lake shipping, costly remedial works and complications with Canada which are more interesting than pleasant to contemplate. The fourteen-foot channel is dead now, or perhaps it might be fairer to say that it has enjoyed a reincarnation in the form of the proposed nine-foot channel now a reality or provided for from Chicago to the Gulf of Mexico except for the reach of a little less than 200 miles between Cairo and St. Louis. Its cost will probably not exceed $6,000,000 while that of the fourteen-foot channel would have been nearer twenty times that sum.[3]

What might almost be termed a mountain-climbing canal was proposed some years ago as a connection between the western end of Lake Superior and the upper Mississippi, the object being the bringing of the Twin Cities of Minneapolis-St. Paul within the zone of lake navigation from which they are now separated by more than 150 miles of rail transportation. The canal was advocated on the ground that it would bring cheaper coal and higher wheat to the "Old Northwest." It would certainly be a picturesque piece of engineering and economics if it were built. The watershed of Lake Superior on its southern side is narrow, the land rises quite steeply and at a distance of no more than twenty miles is from 400 to 600 feet above the lake. Up these hills the proposed

[3] House Document 50, First Session, 61st Congress.

canal would have to climb and, since the Mississippi is only sixty-five feet above the level of Lake Superior a nearly equal decline would be required south of the divide with the result that by one of the proposed routes a total elevation of 1195 feet would have to be overcome, 810 feet of it in thirty-five miles. This would probably be a world's record. The canal would also be another world-beater in that it would have to operate largely without water as the natural supply by this route is declared to be not half enough. Another route subsequently surveyed and known as the Brule-St. Croix was declared by the army engineers in 1916 to be possible but not desirable. This route begins in Allouez Bay in Duluth-Superior harbor, skirts the shore of the lake for twenty-one miles to the Brule River and thence uses the canalized stream up to the summit level which by this route is only 416 feet above the lake. It descends to the Mississippi at Point Prescott, thirty miles below St. Paul, by way of the St. Croix River. The engineers declared that a ship canal was out of the question because of lack of water but that a channel six feet deep, the same as the projected depth of the upper Mississippi, might be constructed for $7,815,000 although they subsequently express their belief that this estimate is based upon insufficient data and is too low. Since they estimated the total rail tonnage between Duluth and the Twin Cities at less than 3,500,000 tons a year they concluded that a canal operating only six months of the year would not draw enough business from the rail lines to pay the cost of construction, maintenance and operation. So this little project is still slumbering in the lap of Fate.[4]

While we are exploring the possibilities along the shores of Lake Superior we should not fail to glance at one on the Canadian side which for constructive imagination and daring excels all waterway projects in North America with the possible exception of the St. Lawrence ship channel. It involves the diversion of a part of the Hudson Bay drainage into that of the Great Lakes, supplying enough water to quench most of the burning problems of navigation due to navigation and power diversions, and forming a sixth Great Lake, twice the size of Lake Ontario, to the north of Lake Superior. Incidentally such a lake might have a tempering effect on the climate of Lake Superior and so delay the closing of navigation in the fall for some days.

As on the southern shore, the northern boundary of the Lake Superior watershed is not far distant, only a mile beyond Lake Nipigon which

[4] Report by Chief of Engineers, House Document 1008, First Session, 64th Congress.

flows into Lake Superior. The floor of the upper Hudson Bay watershed is higher than that of the surface of Lake Nipigon and down its gentle slope flow the Ozoki and Albany Rivers, the former a tributary of the latter, which drains eventually into Hudson Bay. The proposal is simply to dam the Albany River at a point where its level is near enough to the level of Lake Nipigon to permit the level of the impounded waters to rise above the level of that lake, then to cut a tunnel a mile long to permit these waters to drain into Lake Nipigon and the trick is done. The estimated flow is 20,000 c.f.s., enough to more than compensate for the Chicago and all other present diversions from the lakes and so to restore normal levels. More than that, it would raise them enough to make much less expensive the deepening of harbors and channels in connection with a twenty-seven-foot St. Lawrence waterway. The added water it is estimated would produce 500,000 horsepower at Niagara and would raise the height of water in Montreal harbor about ten inches.

As an engineering performance the project appears simpler than the Chicago Drainage Canal but its economic and political aspects are another story. It would cause the flooding of 15,000 square miles of land in northern Ontario. This land is now practically all wilderness but it might not always remain so and it is covered with valuable forest, which would be destroyed by the rising waters. It is proposed to compensate for this by cutting off the forest wholesale before the water rises, a program which would take fifty years to complete. Whether Canada or the province of Ontario would go in for such an extensive program is exceedingly doubtful when it is considered that the chief beneficiaries would be the city of Chicago, the Lakes to Gulf Waterway, and shipping interests on the Great Lakes which are mostly on the American side. It is certain that nothing will be done until maximum diversions are legally established. About all Canada would get out of it would be the deepening of her own harbors including that of Montreal and the use of the 20,000 c.f.s. flowing over Niagara, all of which it would seem she might rightfully and justly claim. The plan remains very nebulous. It is said that the engineering work would not cost over $200,000. It may never be tried but it remains an interesting possibility, worthy perhaps of further study.[5]

But to get away from dreams to something nearer realities, there is one more outside connection of the Great Lakes system which is feasible from an engineering and possibly justified from an economic point of view.

[5] A Sixth Great Lake, *Literary Digest*, January 2, 1926.

That is a proposed canal from Lake Erie to the Ohio River, joining the two ends of the greatest coal and iron region in the country, permitting the ore from Michigan and Minnesota to go by water to Pittsburgh, the coal of the latter to go by water to the lakes and the products of the whole district to find water transport to all the ports of the Great Lakes or of the Mississippi. There are four possible routes. The first and most favored is from Beaver, Pennsylvania, about twenty-five miles down river from Pittsburgh, up the Beaver and Mahoning Rivers and thence down to Lake Erie at Ashtabula, Ohio. The second is from Marietta to Cleveland by way of the Muskingum River, the valley of the Tuscarawas, passing near Akron and thence down the valley of the Cuyahoga to the lake. The third is from Portsmouth to Sandusky, ascending the Scioto River, crossing the divide near Marion and descending the valley of the Sandusky to the city of the same name on the lake. The fourth route is from Cincinnati to Toledo, following closely the route of the old and abandoned Miami and Erie Canal.

The second route is the least desirable from technical considerations. It is the longest, the most expensive, and there is doubt as to the water resources for the summit level. The fourth route is practically the same length, only slightly less expensive. Discussion has narrowed the choice to routes one and three, a choice which depends not merely upon present but future conditions of industrial development in the upper Ohio Valley. At first glance it appears that a canal between Lake Erie and Pittsburgh would do a capacity business. All the Lake Superior ore now used by the steel mills in the Pittsburgh district must now come by rail across this gap of from 125 to 150 miles, which must also be traversed by all the coal mined along the Ohio and its tributaries and destined for the upper lakes. The total of these two commodities transported between Lake Erie ports and the upper Ohio Valley in 1923 amounted to approximately 63,000,000 tons, nearly equally divided between ore and coal. This is three times the capacity of the proposed canal. Here would seem to be traffic waiting for a canal to be built over the shortest route, the 126 miles by way of Beaver. But it is not quite so simple as that. Only half or rather less than half of the coal shipped to the lakes comes from Pennsylvania, the rest comes from West Virginia and neighboring mines whose natural outlet is much farther down the Ohio. Most of the coal produced near Pittsburgh is used near there, including practically the whole of the 20,000,000 tons annually carried down the Monongahela. So it happens that while route 1 is the best

to bring ore from the lakes, route 3 is the best to bring coal to the lakes. Balancing all advantages however it seems that the Beaver route is the best.[6]

As the Ohio is already canalized as far as Beaver it would only require 101 miles of new construction, the least of all the proposed routes, but the expensive nature of the land traversed and the necessity for twenty-six locks would bring the cost to about $120,000,000 or more than $1,000,000 a mile. The total lockage up and down would amount to 559 feet. There would be about 90 bridges across the canal. The total time of navigation from Pittsburgh to Lake Erie would be about forty-one hours. These estimates are all for a canal approximately equal in dimensions to the New York Barge Canal and with a depth of twelve feet. The cost of canals by the other routes between Lake Erie and the Ohio range upward to $195,000,000 for the routes between Cincinnati and Toledo, and from Portsmouth to Sandusky, and to $208,000,000 from Cleveland to Marietta. The canal between Portsmouth and Sandusky, which is the second choice of the engineers, would be 235 miles long, require forty-nine locks for a total up and down lockage of 744 feet, and would require fifty-seven hours for its navigation. It has also been suggested to build a branch from the proposed Cincinnati-Toledo route which would extend to Lake Michigan. This would bring the total cost of that waterway close to $400,000,000 or considerably more than that of the Panama Canal. In view of the approaching completion of the nine-foot channel from Chicago to the Mississippi and of the present deep water navigation between the lakes such an outlay would be a preposterous absurdity.

Much can be said in behalf of the Pittsburgh-Ashtabula route. It is relatively short and there is a great amount of potential traffic in commodities especially adapted to water transport and in large part not subject to a rail haul at either end. Ore would be transferred to the canal from lake steamer and delivered in many cases at the blast furnace. Coal would in many cases be loaded directly from the mine to the barge and, finally, iron and manufactured products would find an outlet by water down the Ohio whose current floated 450,000 tons of such metallic merchandise downstream in 1926. Such a canal would also be a strategic link in an unified system of national waterways. Its completion would mean that the Great Lakes system would be connected with the Atlantic coast at New York, possibly at Montreal; with the Ohio system at Pittsburgh; with the Mississippi by the canal across Illinois. With the

[6] House Document 188, Second Session, 67th Congress.

completion of the St. Lawrence waterway it would make possible water transportation to and from the intensely productive Pittsburgh district and the seaports of the world.

Whether such a canal would pay its way directly or not depends upon whether it would develop its maximum capacity of 20,000,000 tons in any reasonable time. This is one of those factors which it is almost impossible to predict. The history of the New York Barge Canal does not encourage such a view, yet it seems as if conditions for developing traffic were better along the proposed Pittsburgh-Lake Erie route than along the largely idle channel through New York State. Even if the new canal did not seem directly remunerative it might be indirectly so. This consideration opens up questions of economics and public policy which are of the utmost importance in any program of waterway development. Expenditures for public health, education, and good roads do not pay in the narrow sense but they are three of the greatest factors in that productive capacity which has made modern America the marvel of the world. Should waterway development be placed in that class, or should all such public investments be held to the same strict accountability required of private capital so employed? The answer is linked with the question of the needfulness and utility of a system of national waterways, and both of these depend upon broad issues of national policy.

But before trying to get some understanding of these issues upon which so much may depend, we shall briefly glance at the present and future of the Pacific coast inland waterways, which although beyond the compass of any unified national system, present features of interest and of importance.

CHAPTER XIII

West of the Rockies

The Pacific coast of the United States differs from that of the Atlantic geologically, geographically, and in climate. Instead of a sloping shore line rising slowly toward mountain ranges of moderate height, or opening imperceptibly into vast interior valleys, we find on our western coast high mountains coming within sight of the salt water, mountains still in the making, rising within a hundred miles or less from depths a mile below to a mile or two miles above the level of the sea. Instead of the many rivers of the Atlantic seaboard and the many harbors united by great sounds or bays lying back of narrow sand-spits, instead of a great valley such as that of the Mississippi, we find a land of few rivers, most of them short and shallow with steep-walled valleys, rivers whose flow is based not upon an equable all-year rainfall but upon either the rains of a single season or the melting snows from the mountain heights. From San Diego to Puget Sound the surges of the greatest of oceans break almost uninterruptedly against a range of headlands rising abruptly from the sea and giving a promise of the mighty mountain wall not far inland.

Behind this mountain barrier, flowing down from the western slopes of the main continental divide, the Colorado and its tributaries carry the melting snows of the Rockies and the Great Plateau southwestward to the Gulf of California. The Colorado is one of the great rivers of the continent but it is a rapid, turbulent stream not adapted to or used for navigation. West of the Sierras, the whole length of the coast, there are but two main river systems, one of which originates far inland and breaks through the mountain wall at a favorable point. These two systems are those of the San Joaquin and Sacramento Rivers of California, and the Columbia River basin hundreds of miles to the north. The two great rivers of California, draining the Great Valley which extends between the low coast range and the mighty rampart of the Sierras for nearly the whole length of the state, flow eventually into San Francisco Bay. This is one of the two great natural harbors of the coast. The other is that of Puget Sound at our northern boundary. Between them lies the Columbia River which has been deepened and dredged to make a seaport of Portland, 112 miles inland. Near our southern boundary the city of

Los Angeles has made itself a harbor where none was. Further south is the less important harbor of San Diego. These are the only harbors, the only rivers on the Pacific coast which carry any considerable amount of commerce. With the exception of the Sacramento and San Joaquin Rivers and San Francisco Bay there is no present nor possible connection between any two of them. They are independent units.

So it happens that a survey of Pacific coast inland waterways amounts for practical purposes to a survey of the two great California rivers and of the Columbia. The rivers which flow into Puget Sound are small and unimportant and their commerce is almost wholly destined for the sea. Like that of the ports of Seattle and Tacoma it does not properly come within the scope of this book. Much the same is true of the Columbia but that great stream including one of its tributaries, does have a considerable local commerce and the deepening of its upper reaches has been proposed in order to restore their almost vanished traffic. But the Sacramento and San Joaquin are true inland waterways. They are not yet navigable by ocean ships but they lead from one of the richest sections of the country to one of its greatest ports and they bear a traffic of great variety and importance. They and the Columbia will be the two principal topics of this chapter, for between them they exhaust all the large inland waterway possibilities of the Pacific coast.

Between the coast range and the Sierra Nevada Mountains, for a distance of 450 miles north and south and averaging nearly fifty miles across from foothills to foothills, lies the Great Valley of California, comprising 14,000,000 acres of arable land, nearly level, extremely fertile, amounting to three-fifths of all the cultivable land of this, the second agricultural state of the Union. For all the products of the temperate zone, soil and temperature conditions are nearly ideal. Only water is lacking, for this is a land of seasonal rainfall and although over much of the valley and foothills the annual precipitation is equal to that of much of the region east of the Rockies, north of the Platte, and west of the Mississippi River, nearly all of it comes from November to March. The growing season is the dry season. Irrigation is essential to agriculture.

The valley is watered by two large rivers and their smaller tributaries. The Sacramento rises in the foothills of the great mountains which form the natural northern boundary of the state and flows southwards; the San Joaquin rises along the slopes of the Sierras on the eastern side of the southern half of the valley and flows first southwesterly and then

northwesterly to where it and the Sacramento join and empty into Suisun Bay, connected through Carquinez Straits and San Pablo Bay with San Francisco Bay. Each river is navigable for boats of less than eight feet draft for a distance of from forty to sixty miles above its mouth and for boats of lesser draft many miles farther. At the head of the deeper navigation of each river is a considerable city, Sacramento, the state capital on the river of that name, Stockton on the San Joaquin. These cities and the rich agricultural lands near them and up the valleys of both streams provided a water-borne commerce of more than 2,100,000 tons in 1926, of which the Sacramento furnished 1,200,000. Approximately 900,000 tons of the combined traffic of the two rivers was furnished by the fruits and vegetables for which the region is famous.

The lower channel of the San Joaquin is naturally somewhat deeper than that of the Sacramento and is now the scene of one of the most important and interesting inland waterway projects, the creation of a seaport at Stockton, ninety-one miles from the sea. This is being accomplished through the dredging of a channel twenty-six feet deep at low water through Suisun Bay, the present channel of the river, and artificial channels. Depths of more than thirty feet already exist from San Francisco Bay, through San Pablo Bay and Carquinez Straits or nearly half the total distance. Depths of from eighteen to twenty-four feet exist from Carquinez Straits to within fifteen miles of Stockton, except for a few shoals. The estimated cost of the new channel is about $6,000,000 of which the city of Stockton has agreed to pay $3,000,000, the proposal having been approved by the voters of that city by a vote of twelve to one. Coincidentally with the building of the new channel will be a deepening of some of the shallow channels which serve as feeders for the harbor of Stockton. It is expected the whole project will be complete in 1932.[1]

It is asserted by the advocates of the plan, and their assertions are backed up by the United States Army engineers, that the new port of Stockton may be expected to develop a commerce of 1,000,000 tons a year upon the completion of the channel and that the saving in freight rates will amount to $900,000 annually. Stockton is near the center of one of the richest agricultural sections of the country, in addition to which it would be as a seaport a natural outlet for much of the remoter inland region of California and of much of Nevada as well. The history of the ship canal from Galveston to Houston, Texas, fifty miles long and of

[1] House Document 554, Second Session, 68th Congress.

about the same depth as the proposed Stockton channel, which has developed an annual commerce of 10,000,000 tons would seem to indicate a useful future for the California project.

Up-stream from Stockton, the San Joaquin River is shallow with a depth of more than four or five feet not to be depended on except for a few months of the year. For thirty miles or so, however, even this depth furnishes the means for bearing an important commerce. The river divides into a veritable network of sloughs and artificial channels penetrating the rich delta region whose farmers use them as the most convenient way of getting produce to Stockton. Due to the danger of damaging floods, there are few railways or modern highways in this area and four-foot channels give the means of floating down to Stockton shallow barges laden with the products of the farms. As already referred to, these channels are being improved as a part of the development of Stockton harbor.

The Sacramento River is fit only for eight-foot navigation, a ship canal for the sixty miles from Suisun Bay to Sacramento would cost more than present conditions warrant, and improvements projected for the river include only the deepening of the channel to ten feet as far as the state capital. Above Sacramento the river is theoretically navigable for 190 miles to Red Bluff but above Colusa, eighty-six miles upstream from Sacramento, its traffic amounts to practically nothing. Over some part of the eighty-six-mile stretch below Colusa there were carried about 160,000 tons of freight in 1925. The least depth varies from ten to three feet depending on the season and upon the amount of water withdrawn for irrigation purposes from the upper river, and with the mention of irrigation there comes to the front one of the most interesting and unique phases of inland waterway development in the United States.

With the flow of the Sacramento what it is and with the needs of irrigation what they are it appears that there is not enough water to go around. When, in a dry climate such as that of California, water is taken from a river and poured out on the thirsty soil, little more than half of it ever returns to the stream. The rest is a total loss either through evaporation or through seepage to the level of underground water below the stream. The flow of the Sacramento is itself seasonal in character; greatest in the spring and early summer, least in the late summer and fall when the demands upon it for navigation, for the bearing to market of the crops its waters have helped to raise, is at its greatest. That navigation demand is a few weeks after the greatest demand for

irrigation, during and after midsummer when the moisture accumulated in the soil during the winter rainy season has been exhausted and when the ripening crops imperatively need the life-giving water. But, if too much water is taken out in July for irrigation there will be such shoal water on the sand bars in September that water transport will be out of the question over much of the stream above Sacramento. And that is not all the damage.

The lower reaches of both the Sacramento and San Joaquin are sluggish, with so little natural current that the tides of the sea are preceptible in times of low water as far up-stream as Sacramento. Normally, the salt water does not come above the junction of the two rivers but if from any cause the flow of the Sacramento or the San Joaquin falls below a definite minimum the volume of fresh water is not sufficient to hold back the sea water from penetrating the river channels. The region through which these channels flow is highly cultivated and the water upon which its irrigation depends comes from the rivers which, if they become brackish, become useless for that purpose with resulting calamity to the crops. Extreme low water is, as we have just seen, in part dependent upon irrigation withdrawals in the upper rivers, especially the Sacramento. The practical problem then is how to balance the needs of the farmers in the upper valley and the delta, and how to reconcile the needs of both with the demands of navigation.

The obvious answer is to provide water enough for all, but that is much easier said than done. There are two ways of attempting it; one by damming the lower river, the other by increasing the low water flow of the upper river. It has been proposed to build a dam and lock about twelve miles downstream from Sacramento which would give a depth of six feet up-stream as far as Colusa even at times of low water and provide for all year navigation to that point irrespective of the irrigation diversion farther up-stream. This would solve the navigation problem but it would mean the ruin of the agricultural lands along the lower river, for the flow of the stream thus being interfered with, the salt water would penetrate close to the foot of the dam. So a far more ambitious undertaking has been proposed, that of damming Carquinez Straits and making all of Suisun Bay and the waters above unalterably fresh. But to build a dam across the straits, three-fourths of a mile wide and from thirty to ninety feet deep, and to provide the huge locks needed to accommodate the ships which will use the new Stockton ship channel, would cost at least $70,000,000, a sum which has so far given pause to all construction programs.

The only other apparent solution of the problem in a way to please everybody is to increase the low water flow of the river by the building of reservoirs along its mountain sources and to release during the dry season the water impounded there during the rainy season. No less an authority than Herbert Hoover, who can not only qualify as an engineer but as a Californian, has said that there is enough water could it be so conserved to furnish "at some price all the storage that we need."[2] But these works are costly, one single reservoir would require $30,000,000, and plans for them are not yet at the practical stage. So there the matter rests with the only immediate way out the attempted balancing of interests, and with the emphasis given first and foremost by California to the needs of irrigation upon which the agriculture of the state depends. Even the shipping interests on the rivers are said to realize that unless there is water enough for the farmers there will not be freight enough for their boats. An interesting sidelight on the problem is the actual shipment of fresh water down stream by barge to industries along the lower delta which need it in their operations. There were more than 500,000 tons of water so shipped in 1924 on the Sacramento.

Such is an outline of the inland navigation of California which in variety, value, and actual and potential importance is equaled nowhere else on the Pacific coast. It includes even a large passenger traffic in modern river steamers that operate between San Francisco, Sacramento and Stockton, 190,000 passengers having been carried in 1926. The Golden Gate, through which more tonnage passed in 1925 than through any other single channel to the sea on either coast except that through the ocean gateway of New York, is the entrance to one of the two great natural harbors of the western coast and to a great system of inland navigation whose full development is only a question of time. Backed by a rich and growing state, the second in agriculture in the Union, opening into one of the great natural harbors of the world on the greatest of oceans, in close touch through the Panama Canal with the rich markets of both shores of the north Atlantic, the inland water commerce of California presents possibilities unequaled save in the St. Lawrence waterway and the Mississippi.

Northward for hundreds of miles no harbor nor river of consequence breaks the granite barrier of the coast until the mouth of the Columbia offers a fair entrance to the greatest river flowing into the Pacific Ocean on its eastern shore. Like the St. Lawrence, the great river of eastern

[2] Address before Columbia Basin League, Seattle, August 21, 1926.

North America, the Columbia is an international stream, rising in Canada and traversing there several hundred miles of its course before crossing the boundary into the state of Washington through or past which it flows for about 760 miles, forming during the last 250 miles or so of its course the boundary between that state and Oregon. Its largest tributary is the Snake, rising in Yellowstone National Park and traversing parts of Wyoming, Idaho, Oregon, and Washington. Another important tributary is the Willamette which empties into it from the south ninety-nine miles from its mouth and on which the city of Portland is located.

For all of its great length, the larger part of the course of the Columbia and its tributaries bears but a trifling commerce. This is due in part to the still undeveloped character of much of its watershed and in larger part to the nature of the stream. For the most part it is rapid and rough, its current frequently torn by rocks or shoals and so swift that steamboats can make but small headway against it. Most of these obstacles lie above the mouth of the Snake but below that point the broken water of the Dalles and the Cascades requires canals about them and acts as a bar to profitable through traffic. It is only in the last 150 miles of its course that the Columbia has any commercial importance and there it plays a leading part in the development of the northern Pacific coast. In the early days of the pioneers its upper reaches were busy with steamboats but the railroads did the same work better and the upper river commerce is nearly dead. But below the entrance of the Willamette, which feeds into the larger stream the commerce of Portland, and for some distance above that point, that Columbia is one of the most important of our rivers and incidentally one of the most beautiful.

From the sea to the mouth of the Willamette, and for the remaining dozen miles up that stream to the docks of Portland there is a channel thirty feet deep open all the year, a channel which in 1926 carried a commerce of 8,600,000 tons, not including nearly 2,300,000 tons of rafted timber. This commerce was of the value of $356,000,000 and of great variety; more than two-thirds was ocean-going, approximately 2,300,000 tons being handled by river vessels and destined to river points.

From the Cascades up-stream to the international boundary there is now no navigation on the river worth more than brief mention. Although 39,000 tons of freight were carried through the canal at the Cascades in 1926, no traffic through the canal at the Dalles was reported. Above that point there has been no traffic reported whatever since 1920 except on the Snake River which carried a little less than 24,000 tons in 1926.

Above the international line the river is navigable for much of its course in British Columbia and parts of its tributaries are navigable for relatively short distances but through navigation does not exist. If the river should ever be extensively developed for power purposes and especially if the great project for irrigating some 3,000,000 acres in the Columbia Basin in central Washington by means of a dam 200 feet high should ever become a reality, the improvement of the navigation of the upper river might be practicable. As it is now such an attempt would be ruinous and costly folly.

Beyond Portland the Willamette carries a considerable and varied traffic, even with a depth of only six feet, having averaged 650,000 tons a year for the five years ending in 1926. This does not include a nearly equal tonnage of floated and rafted timber. These figures comprise the commerce on the Yamhill, a tributary of the Willamette.

Future developments of the inland channels of the Columbia River system indicate no radical changes for years to come. The ship channel to Portland may be deepened to thirty-five feet and the river further deepened to the city of Vancouver, Washington, four miles above its junction with the Willamette. Considering the trade on the Willamette, a further deepening of that channel might be justified; but the upper Columbia will have to wait at least until power and irrigation developments make navigation possible as a by-product. Even were it possible to increase the depth to nine feet at something less than prohibitive expense it is doubtful if the river would draw much traffic. The swift current would make barges difficult to handle and the best judgment is that on rivers and canals barges or bulk carriers are the only craft that will pay. The old-time river steamboat still survives here and there but as a freight carrier pure and simple it is dying if not dead, except where traffic enough to make bank landings profitable exists.

Successful waterway transportation is not simply a matter of deepening a river or building a canal. The traffic must begin or end somewhere else than in freight cars, preferably at points of ultimate origin or consumption or alongside ocean carriers, and it must be carried in craft built to fit the waterway rather than those which the waterway has been built to fit, unless the artificial channel is a short link between natural deep waterways. These are some of the primary requirements for successful inland water transportation which, now that we have completed our survey of the liquid highways of the country must be examined a little further before we can try to determine what the future development of our waterways shall or should be.

CHAPTER XIV

Will It Pay?

In the century and half following the Declaration of Independence, the federal government spent upon rivers, canals, and harbors nearly $1,500,000,000. No accurate and comprehensive tabulation has ever been made covering the entire period, the closest being a reckoning of all federal appropriations for these purposes from the first congress to and including the fiscal year 1927. This amounted to a total of $1,445,000,000.[1] These figures do not include expenditures by states, by smaller political units, or by private enterprise. It seems probable that $2,000,000,000 would not be an extravagant estimate for the total cost of all our improved harbors, coastwise, and inland waterways. Has it paid?

There is no question whatever as to the answer with respect to those improvements which have made possible or made easier our foreign commerce. There is no question with respect to the commerce of the Great Lakes. Irrespective of the wisdom or folly of individual projects, the general policy which has resulted in a foreign commerce for the year 1926 of 114,000,000 tons, valued at $8,500,000,000, and a lake commerce of 137,000,000 tons, valued at $2,109,000,000, needs no further justification. The main question hangs upon the value of the service resulting from the expenditure of probably $500,000,000 on purely inland projects such as rivers and canals. As to the remote past there is again not much question, at least as to the past before railroads began to be an important means of communication. It is the expenditures in the past fifty years which raise doubts in many minds and it is especially the possible cost of future development about which the debate as to the value of inland waterways rages. In 1926, the inland waterways of the United States, exclusive of the Great Lakes, carried 217,000,000 tons valued at $3,680,000,000. In 1925 the railroads, which are the direct competitors of this means of transport, carried 2,390,000,000 tons or about eleven times as much.[2] Is it worth while to spend millions of money in developing waterways when railways having approximately the same terminals and

[1] *Report of Chief of Engineers, United States Army*, 1927, part I, page 6.

[2] *Railway Statistics of the United States*, 1925, Bureau of Railways News and Statistics.

covering the same territory accomplish nearly twelve times as much service? With these ultimate facts in mind, do rivers and canals pay and is additional development of them justified?

The spending of public money may be justified in two ways. It may result in a direct cash return or it may result only in the protection, the safety, the health, or the growth of the state or community. An example of the first sort of return is a successful municipal lighting plant; an instance of the second is the money spent for police or schools. Since wars for conquest or colonization became impossible, no war has ever paid as an investment, and in times of peace the money spent for preparedness is nearly a total loss. Only war brings partial dividends. Yet nations consider such money well spent for the same reason they consider money for schools or health well spent and for the same reason a wise man thinks money for his own health or advancement is not wasted although no direct return may ever be evident save in increased earning power.

Waterways come into the latter class of public expenditures. Except where they are, like the Panama Canal, in the nature of a toll-bridge, they seldom pay a direct return. Indeed, since the navigation of all our rivers and nearly all our canals is free, there can be no such return. The only possible return is through indirect saving to shippers through lower rates, or through the increase of the earning power of the nation because of better transport facilities. National defense may also be a justification of a waterway. But unless such a waterway can ultimately attract business enough to make the cost of it per ton of freight carried not more than the cost per ton of other competing methods of transportation, or unless the waterway serves a region inaccessible in other ways, it is impossible to justify spending money upon it except as a measure of national defense. The test of a waterway is traffic; not always actual traffic but the traffic which may reasonably be expected when the waterway is complete.

Now when we get to talking about traffic we get into the region of direct returns for money spent, that is, from the point of view of the shipper. He will not send his goods by water unless he can do it for less than by land or unless no land transport is available. He is bound to send them by what, all factors considered, is the cheapest way; and unless a waterway can prove to him that it is the cheapest way he is not going to use it and it is not going to justify the money spent on it. The Great Lakes as a waterway are a tremendous success because they offer for

certain sorts of goods lower transportation rates than by any other method. The New York Barge Canal is as yet not a success because it has not attracted enough business to justify its cost and it has not attracted the business because it has not convinced shippers that it offers what in the long run is a cheaper way of transport than the railroad.[3]

From the shipper's viewpoint, the actual freight rate on the waterway is far from telling the whole story unless he and the receiver of his goods both do business upon its banks. For most business there are four other factors to be considered. These are the cost of getting the goods to the waterway, of getting them afloat, of unloading them, and of final delivery. These may for convenience be reduced to two, feeder haul costs and those of trans-shipment. The reason why some waterways do not attract traffic is almost always to be found in the fact that the sum of all these costs equals or exceeds through railroad freight charges. This is especially true for large concerns which have railway trackage direct to their warehouses or from their factory.

The economics of waterways from the point of view of the shipper are nowhere clearer expressed than in an article in the Memoirs of the Corps of Engineers written by Colonel C. McD. Townsend in 1910.[4] It will be freely and directly quoted in this and the succeeding paragraphs. He begins with the fundamental fact that the friction caused by a solid body moving through a fluid is much less than that of any solid moving over any other solid. A team can pull a plow with difficulty but can move a 200-ton canal boat through the water with ease. "The expenditure of coal that will propel a freight train carrying 1000 tons of freight at a speed of eighteen miles an hour on the Lake Shore and Michigan Southern Railroad will drive a steamboat with 5000 tons at a rate of twelve miles an hour on the Great Lakes."

But that is not all the story as we have seen. The cost of feeders and of trans-shipment must be considered and Colonel Townsend combines all these factors into a mathematical expression which is so simple and lights up his argument so well that I shall quote it as well as his exposition of it, for in it lies the key to the success of water transport. The expression which determines the conditions under which goods will seek a water route rather than a rail is,

$$ax + cz + d < by + d'.$$

[3] Based on construction and maintenance charges it cost $4.51 to move the average ton of freight on the canal in 1925.

[4] *Professional Memoirs, Corps of Engineers*, volume 2, pages 20–29.

If the character $<$ is explained for non-mathematical readers as meaning "is less than," anyone with a knowledge of simple arithmetic should be able to follow the argument. The other characters mean as follows; x, y, and z, represent the distance in miles along the route taken by the shipment by river, by railway, and by connecting lines respectively; a, b, c, represent the rates per ton-mile by these respective methods, and d and d' represent the respective cost of loading into boat and freight car. Applying these to our expression we see it reads; the cost of travel on the river plus that on the connecting lines plus the cost of loading into the boat, is less than the cost of travel wholly by rail plus the cost of loading the freight car. Says Colonel Townsend,

"Assume now, that freight can be carried on a river 100 miles for three cents a ton. Let us imagine a town ten miles from the river connected by rail to a river town 100 miles distant, but having only a country road to the river. A team would have difficulty hauling one ton to the river and returning the same day. Suppose the teamster charged $2.00. It would therefore cost $2.03 to move freight between railroad terminals by the water route and the railroad could charge two cents a ton-mile or $66\frac{2}{3}$ times the assumed cost of water transport and the shipper would still save the entire cost of water transport by rail shipment.

"If we assume the imaginary town is connected to the river bank by electric line which transports at four cents per ton-mile, the water side of our mathematical expression would become forty-three cents and the railroad would have to cut rates from two cents to four mills a ton-mile or lose the business.

"But the assumption that a short haul by water can be made at three-tenths mills a ton-mile is absurd. It is more accurate to say that with the same expenditure of power about five times the freight that can be moved by a railroad can be handled by water; but under such an assumption according to our mathematical expression, the distance from the river to a town that could profitably utilize a river route 100 miles long would be about forty miles if there was a connection with an electric road willing to carry freight at double the steam rail rates, while by ordinary country road that limit would be reduced to less than two miles.

"However, for the water route to succeed it must carry freight in large quantities, in which case the connecting railroad would be moving freight in carload lots. It could then transfer its car to another railroad without breaking bulk and d' would equal 0. As it costs at least twenty-five cents to load a ton of freight into a boat or back into a car, and as a railroad with good grades can carry freight in trainload lots at two mills per ton-mile, it is readily seen from our expression that a canal 250 miles long will be unable to compete with railroads if it receives its freight from cars at one terminal and delivers to cars at the other.

"The mathematical expression shows that the cost of movement of freight over lateral feeders practically confines the benefit from many waterways to the towns located on their banks."

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Photos by United States Engineer Corps.

Upper: Eight Barges of Steel Products Bound Down the Ohio Near Pittsburgh
In 1928 a similar tow of sixteen barges carrying 12,000 tons of fabricated steel passed down the river. The movement of steel on the Ohio is assuming great importance.

Lower: Typical Ohio River Coal Tow Leaving Lock No. 6, Bound Downstream
The barges are loaded at the mine. The dam is shown in midstream

The figures given by Colonel Townsend are those of 1910 and do not strictly apply today but the principle still holds. It also follows that if loading costs increase more in proportion than rail costs the waterway is at increased disadvantage. A concrete illustration may be seen in the coal movement on the Great Lakes in 1923. Chicago is by water approximately the same distance as Duluth from the coal ports on Lake Erie. There are however coal mines in southern Illinois about 250 miles distant. Duluth received by the lakes more than 10,000,000 tons of coal; Calumet harbor which supplies much of Chicago, 1,100,000 tons; Chicago an insignificant amount.[5] But Chicago did receive something like 18,000,000 tons of coal by rail.[6] Milwaukee farther from the mines received 3,000,000 tons by lake.[7] In other words it was cheaper to ship coal all rail from 250 to 500 miles than to ship it 125 miles by rail and then transfer it to a lake steamer.

It is certain that no waterway will ever attract traffic unless the following conditions are met. Its feeder rates must be low. Its trans-shipment charges must be low. Its own rates must be low and all together must be less than those by all-rail. These conditions can only be met by coöperation with the railroads and joint rates, by modern terminals, by modern boats operating over a suitable route and bearing balanced cargoes. The relative importance of these factors depends on the nature of the traffic and on whether it is carried by a private, a contract, or a common carrier. A private carrier is one who transports his own goods exclusively; a contract carrier transports those of a few persons or corporations to the exclusion of all others; a common carrier transports the goods of all upon equal terms. The bulk carriers of the Great Lakes are good examples of private or contract carriage; the old-fashioned river steamboat and the modern service of the Inland Waterways Corporation of common carriage.

It is evident that the private carrier need not worry about feeder charges. The Standard Oil Company for example carries its products on the New York Barge Canal directly from its refineries to its own wholesale distributing stations, using its own boats. For such a carrier only a suitable channel is needed to make its operations an assured success. The bulk freighters of the Lakes, either owned by the steel companies or under charter to them, have little to worry about either.

[5] *Transportation on the Great Lakes*, pages 307–308.
[6] *Report on Nine-Foot Channel.*
[7] *Transportation on the Great Lakes*, pages 307–308.

Their feeder rates are of the lowest and because coal furnishes a balanced cargo on a round trip they can carry it at rates far below any rail competition for the greater distances. But if the mines are within 250 miles of a large market as in the case of Chicago even that water traffic must bow to the railroad. The chief needs of the private and contract carriers are suitable terminals and boats for their class of cargo, conditions which the Lake freighters meet admirably. For the common carrier by water, the boat line which carries general merchandise or bulk freight on equal terms to all, the chief requisite of success is low feeder rates secured through coöperation with the railroads. This is the chief factor in the success of the Inland Waterways Corporation on the Mississippi. Through the orders of the Interstate Commerce Commission or through voluntary action on the part of the railroads it has secured joint rail and water rates with many railroads. Its through rates average about eighty per cent of the competing all-rail rates and the reduction is divided between the water and the contributing rail lines so that the latter rates are under those for goods destined only to the river port. For example, wheat from Kansas City to New Orleans by rail to St. Louis and thence by the river, pays less freight from Kansas City to St. Louis than does a shipment whose journey ends at that city. Unless a common carrier can receive freight from points back from its water highway under these conditions its usefulness is limited to points along or near the waterway, or connecting directly with it by water. The Inland Waterways Corporation has succeeded because it has one of these advantages at one terminal and the other at the other end of its route, for New Orleans is a seaport and furnishes and forwards freight at the lowest of all rates.

Another essential factor is the fitting of the equipment both in boats and terminals to the needs of the traffic. The old-time river steamboat is dead as a common carrier to any except rail-isolated points because a railroad can carry a ton of freight several hundred miles for what it costs to get it from the freight car on board the steamer by the old methods of hand labor. The old-time river steamboat was not a cheap means of transport as compared with railroads. Far from it. It carried a crew of 30 or 40 to handle perhaps 500 tons of freight while half a dozen men on a modern barge line can handle 1500 tons. Rates on the old Mississippi lines would be considered exorbitant today. They averaged on the upper river about ten cents per ton mile at the height of the steamboat era. This is about nine times the average rail rate of today.[8] The

[8] *Old Times on the Upper Mississippi*, pages 164–172.

boats, if not wrecked, were enormously profitable because they held a monopoly. Profits of 100 per cent in a single season were not uncommon. Similar conditions prevailed on other inland rivers. The steamboat was a great economic improvement over the flatboat, the keelboat or the freight wagon, but it fell before the railroad because it was doomed to and right that it should. No program of inland navigation that pins its faith on a revival of the old-time steamboat will ever succeed until railroads become a thing of the past.

The future of these flowing highways depends upon the adaptation of equipment to modern economic conditions and to the channel. The use of barges equipped for labor saving loading machinery, the use of terminals so equipped, the direct connection of the wharf with rail, ending expensive trans-shipment by hand, all these are essential if a common carrier by water is to make through rates low enough to compete with rail. Communities along the Ohio and Mississippi are realizing this and are building modern terminal equipment for their water traffic and it is the increasing use of such methods more than any other factor except the improvement of the navigable channel which has increased the commerce of the Ohio 12,000,000 tons in half as many years and which in conjunction with joint rates has developed the business of the Inland Waterways Corporation from 360,000 to 1,300,000 tons in the same period of time.

The equipment must not only be fitted to the traffic but to the channel. An impressive illustration of this is the all-too-often neglected fact that until the development of modern methods on the inland water routes their period of greatest traffic was before any material improvement of the channel had been made. A shifty, shallow stream was taken as a matter of course and boats were made to cope with it. Rivers were then considered navigable that have scarcely seen a steamboat in forty years. These shallow draft boats built to float "on a heavy dew" died before the victorious locomotive but they left one valuable lesson and that is the advantage of fitting the boat to the river rather than the river to the boat. Modern requirements require a modern application of this truth; the day of the three-foot steamer is past, but the experience of the past few years has abundantly indicated on the Mississippi, the Ohio, the Monongahela, that a draft of six to eight feet is sufficient for a barge of modern design and equipment, capable of competing with railroads; and that the attempt on purely inland channels to secure a depth of more than nine feet is unnecessary and wasteful. It is probable that the development of river and canal traffic will result in the invention of types

of boats capable of using these channels more economically than any yet built if the designers and the shippers and the people who try to inform the public will get out of their heads the idea that a modern river vessel must be something like the old steamboat. Railroads and automobiles never came into their own until their designers forgot the stage coach and the buggy.

Leaving aside as too technical for a general work of this sort a discussion of the important factor of balanced cargoes, there is one final requirement for the success of an inland water carrier. It must go somewhere. There is no place in our waterway development for a channel without other than rail terminals. Such is bound to fail. There is little place for the development of coastal rivers paralleled by railroads unless those rivers have particularly good channels, flow through a populous industrial or agricultural region and end along some larger inland waterway. Unless a channel has these advantages it will never attract traffic enough to make it worth while.

But if all these factors are considered, if we have a suitable channel, plied by modern boats using modern equipment, deriving much of their freight from coöperating rail or boat lines, we will find a waterway that is used, a high road of commerce such as the Great Lakes, the Ohio, or the lower Mississippi and it seems reasonable to suppose that such a waterway will pay; that is that the sum of its benefits to the nation will more than equal a fair rate of return on its cost.

Many railroad critics of waterways have tried to show that no river or canal channel has ever paid if all factors of cost have been considered and that railroads might be built at the same cost as new waterways. This seems an idle argument. On the Mississippi and Ohio the money has been spent and if the waterway be not preserved and improved it will be money wasted, a total loss. The interest charges will go on just the same. The only real question is as to new expense, whether it is worth while. Many ridiculous estimates of the relative cost of waterways and railroads have been made by railroad propagandists. For example in the 1924 edition of H. G. Moulton's *Waterways versus Railways* (page 407) it is stated that the cost of the Ohio River improvement is $71,000 a mile and that in the region served by the Ohio and lower Mississippi a railroad might be built, "exclusive of terminals" for less than $35,000 a mile or at a total cost of $31,920,000 from Pittsburgh to New Orleans. This, I submit, would be good news to the railroads. Leaving aside the value of any railroad without terminals and insisting on the necessity of such appendages to any transportation system, let us turn to some official

figures on railroad costs. The bulletin, *Railway Statistics of the United States of America for 1925* (page 4), published by the Bureau of Railway News and Statistics, gives the average capitalization of all our railroads in that year as $78,635 per mile of line. Poor's *Manual of Railroads for 1926* gives the total capitalization and funded debt of the Illinois Central Railroad at $514,000,000 or a little more than $112,000 for each of its 4580 miles owned. Similar statistics give a mileage value of $85,000 for the Louisville and Nashville, operating in the same general region. Another railway advocate, writing in 1912, gives the probable cost of a double track line from Chicago to New Orleans at approximately $100,000 a mile, these figures let it be noted, being at pre-war prices. When authorities disagree it is for others to doubt.[9]

There can be no doubt of another set of figures,[10] those showing the growth of American railroad capital and tonnage. Capital invested in our railroads increased $3,900,000,000 in the ten years ending in 1925 during which time the increase of line mileage amounted to just 1649 miles or an expenditure of more than $2,000,000 a mile. Of course it is only fair to say that most of this expense went into improved terminals and equipment which is reflected in an increase of annual traffic for the decade of 344,000,000 tons but when it is considered that this ten-year outlay by the railroads is nearly twice all possible expenditures on our rivers and harbors during the past 150 years and that the annual water commerce resulting in part therefrom amounts to 540,000,000 tons it does not seem as though the money spent on waterways had been wastefully used. Or, let us consider the total capital investment in American Railways in 1925, some $19,000,000,000, resulting in traffic facilities for 2,390,000,000 tons of freight. This amounts roughly to $8 for every ton. Assuming $2,000,000,000 as the total cost of our waterways and harbors which in 1926 bore 540,000,000 tons it will be seen that the cost comes to less than $4 per ton.

The argument that waterways are always a wasteful extravagance and that railways are always cheaper will not wash. Neither will the one that waterways are invariably to be preferred. Each case must be judged on its own merits and these merits so far as the attraction of traffic is concerned have been outlined in this chapter. The case for any one waterway rests upon them; the case for waterways as a general policy of the government and as a future accessory transportation system rests upon wider considerations, presently to be discussed.

[9] *Lakes to Gulf Deep Waterway*, W. A. Shelton.
[10] *Railway Statistics of the United States*, 1925.

CHAPTER XV

Looking Forward

Time has been likened by many poets to a river which bears us all onward toward an unknown destiny. The figure fits national policies as well as the mortals who shape them and it is peculiarly appropriate to a discussion of waterway development. For many years the national policy with respect to these flowing highways has been to drift with the stream, a stream beset with many shifting and unknown dangers. It is now becoming our policy to direct if possible the course of this mighty river of commerce, to control its vagaries, to remove obstructions to its flow, to widen and deepen it, to multiply its sources and to extend its outlets so that when all is done it may be not a treacherous stream but a steady, dependable current of our national destiny.

In an address before the National Rivers and Harbors Congress of 1927, Herbert Hoover, then Secretary of Commerce, spoke a thought-compelling word when he said that the future development of the United States would be more in the direction of developing the water resources than the hidden wealth of the land. Water resources include power and irrigation as well as navigation but there is no question but that a movement toward development of the navigable waterways of the nation is under way, is gathering strength, and deserves the best thought, the best nurture, the best direction, based upon the most complete available information. The extent of the present achievement may be summarized in one sentence which merely states that in 1926 the purely inland waterborne commerce of the United States, carried on not more than 25,000 miles of a piece-meal system upon which not more than $1,000,000,000 has been spent, amounted to approximately 100,000,000,000 ton-miles of freight, very nearly one-fourth as much as the total for 248,000 miles of modern, uniform coördinated railroad transportation capitalized at approximately $20,000,000,000.[1]

Waterway improvement will pay for itself in traffic as we have seen, provided it is undertaken with due regard for present conditions. But it has a larger return than the actual amount of freight moved. There

[1] *Report of Chief of Engineers*, 1927, also *Railway Statistics of the United States*, 1925.

are less tangible benefits in the way of lower freight rates on competing railroads and of the economic development of the region served. If, for example, we assume the saving in freight rates due to all possible factors to amount to the very conservative figure of one-tenth of a cent per ton-mile for the freight actually carried by purely inland waterways the annual gross saving amounts to $100,000,000 or nearly twice the present annual expenditures for the development and upkeep of our rivers, harbors and canals. The part played by the old Erie Canal, the Ohio River, the Ohio canals, in the growth of the nation has already been told. A similar and no less important part may be played by a comprehensive, modern system of water transport, coördinated with the railroads, and serving that vast, populous region between the Appalachian mountains and the Rockies, now seriously handicapped in its effort to win its share of national prosperity. It would do even more.

Economics and engineering are better cures than politics for most of those dislocations of supply and demand which rise to the height of national problems. One of the most insistent of these problems is that of the western farmer and many politically-conceived schemes have been thought of to solve it; but a reduction in the cost of the transport of grain from Kansas City or Duluth to the Atlantic or Gulf Coast of from ten to fifteen cents a bushel, an achievement well within the possibilities of a unified waterway system, would do more for farm relief than ten decades of subsidies or oratory. Without such a system the lot of the farmer in the midland states will be increasingly difficult for the time is coming when the growing populations along our coasts, faced by increasing cost of living, will demand relief through lowering of the tariff on agricultural products, admitting the grain of Argentina, the butter of New Zealand, the bacon of Denmark at prices with which no farmer of Illinois or Nebraska provided only with rail transportation, can meet. The thing has happened before and for the same reason. During the early decades of the nineteenth century, before the full development of the Erie and Ohio Canals, wheat was imported at New York and other seaboard cities while farmers in Indiana and Ohio would have been glad to sell it for twenty-five cents a bushel. The opening of waterways to the west ended that situation for nearly one hundred years but today there is a continuing contest between the western farmers who want to raise and the eastern city dwellers who want to lower the tariff on the products which the one produces and the other eats.

But the "farm problem" is not the only one connected with costly

transportation. The cost of lumber has risen in recent decades and nowhere more than in the treeless prairies of the midlands. The two main sources of lumber are now the Pacific northwest and the Gulf and South Atlantic States. The transportation picture of this commodity shows nearly 1,500,000 tons carried annually through the Panama Canal and nearly half as much again shipped coastwise from South Atlantic and Gulf ports. It shows lumber carried by water from Puget Sound to New York, trans-shipped to the Barge Canal and carried as far west as western New York. The canal carried 31,000 tons of such Pacific coast or Southern lumber on 1926.[2] If lumber might be shipped all the way by water from Puget Sound to Chicago without trans-shipment it would not cost as much as it does now to build a house in Illinois or Iowa.

Then there is a fuel problem. Coal operators complain of a lack of demand; consumers complain of high prices. An answer in part to this difficulty is seen in the 20,000,000 tons of coal floated down the Monongahela to Pittsburgh in 1926 and the more than 8,000,000 tons shipped on down the Ohio. Southern Illinois contains great coal fields; an improvement of the upper Mississippi, of the Missouri, of the Illinois, might make coal worth more at the mines and less at the furnaces of Chicago, Kansas City and Omaha. But there are many other problems of production and distribution, too many to tell of, all a part of that greater problem of maintaining the American standard of living, a problem of increasing gravity and importance. It has been stayed for the time by the restriction of immigration, the tariff, and the economies of mass-production but these are only palliatives which it will survive.

The best authorities on the growth of population agree fairly closely that, unless there should be some unforseen calamity or some revolutionary discovery or invention, the population of this country will be about 200,000,000 at the end of this present century, which many children now able to read will witness. There will be 70,000,000 more people than there are now, an increase greater than the whole population of the country in 1890. There will not be any more land. There will probably be not as much land capable of production as there is now. At the same time we shall be faced with the competition of a world beyond our borders also more populous, more hungry, with lower standards. Under those conditions what is to prevent the standard of American

[2] *Report of the Superintendent of the New York State Department of Public Works*, 1926.

living from falling to something like that of our competitors for survival? Chiefly two things; cheaper production through better use of our power resources, and cheaper interior transportation. Water transportation is naturally the cheapest of all. The better use of what facilities we have, the development of others as the need develops, is the sole apparent answer to one-half the solution of the biggest material problem before the American people. It is a national problem. It can not be solved by the states for nearly all waterways cross state boundaries. It can not be solved by private enterprise because the lakes and rivers are free and must always remain so. The states and private individuals or corporations can contribute to the development but in its conception and execution it is a task for the nation because it ministers to a national need which no less inclusive political or social unit can properly or adequately supply.

The need is for a national, unified, coördinated system of inland and coastal waterways which will provide an auxiliary system of transportation to railroads and highways, co-related with both of them and possibly with air transportation, the whole forming one national system of transport. Furthermore, so far as the continent of North America is concerned it must be in part international The greatest single unit of the system, a ship canal to the Great Lakes, requires some coöperation with Canada no matter what route is used. Canada is and will continue to be a next-door neighbor with whom we must live not merely on neutral but on friendly terms unless we want to turn North America into a nest of oppression or of barren wrangling that will off-set if not prevent any permanent material progress. The waterway system must embrace the Lakes, provide at least one ship canal to the Atlantic coast, connect them with the Mississippi system in one or more places, develop that Mississippi system to its utmost practicable extent and connect it with an inland coastal waterway from the Rio Grande to Massachusetts Bay. That waterway in turn must be fed wherever practicable with streams of water-borne traffic flowing down coastal rivers. Finally the rivers of the Pacific coast must be utilized to their fullest capacity for navigation.

This is a long program in its completeness. It can not and should not be attempted at once, but a start should be made toward the completion of those parts of it most urgently needed and easiest to complete. This includes as one of the first objectives, the St. Lawrence Ship Canal. The others are the completion of a six-foot channel to the head of navigation of the Mississippi, of a nine-foot channel by way of the Illinois River to Chicago, of the nine-foot channel of the Ohio to Pittsburgh, of chan-

nels at least six feet deep in the Missouri, the Tennessee, and the Cumberland for as far up-stream as conditions warrant, of the Gulf coast inland waterway from Mobile to the Rio Grande, and of the Atlantic intracoastal waterway from Cape Cod to Miami. These are all practicable projects, all under construction, all not far from completion if work were actively advanced.

To complete this immediate program, exclusive of the St. Lawrence and the coastal waterways, would cost about $100,000,000 to $120,000,000.[3] Adding $150,000,000 for the net cost to the United States of the St. Lawrence Ship Canal, and $100,000,000 for completion of the coastal waterway including a twelve-foot canal across New Jersey, gives a grand total of $370,000,000 for the completion of a unified system of inland water transport from Minneapolis, Kansas City, Pittsburgh, Duluth and Corpus Christi, to Montreal, Boston, New York and other Atlantic coast ports. This is very nearly the sum by which the railroads of the United States increased their net capitalization in the ten years ending in 1925 and is just about the cost of one week of the World War to the people of the United States. It would make it possible for ships or barges to enter the Great Lakes from the seacoast, and for the barges to proceed directly to all ports from Boston to Miami without serious risk from outside navigation. A gap would remain from Florida to Mobile but there the Warrior and Tombigbee systems would connect with a unified system of channels connecting all the Gulf Coast and the main streams of the Mississippi system which would also be connected with the Great Lakes system at Chicago. It would be possible to go from the mouth of the St. Lawrence to New Orleans by inland routes for at least seven months of the year although it must be said that unless some special type of boat is evolved, trans-shipment would be necessary.

The outline of the immediate program for the Mississippi system resembles a huge irregular cross with the main river to Minneapolis the upright and with the cross arm formed by the Missouri and Ohio Rivers as far as Kansas City and Pittsburgh. Only 1100 miles of this system of more than 3300 miles remain uncompleted while the additional completion of links aggregating 1100 miles along the main tributaries would open to barge navigation 6000 more miles of waterways. The cost of this part of the work including the nine-foot channel to Chicago, would be $100,000,000 and it could be completed within ten years, much of it

[3] Secretary Hoover's statement to River-Harbors Committee of House of Representatives, January 30, 1926.

within half that time. At present the system is like that of the railroads before the Civil War when many different gauges prevailed and transshipment was frequent even where, as often happened, there were not absolute gaps in the line of transport. Relatively few miles of shoal channels prevent through and systematic navigation and yet as we have seen the traffic of this somewhat fragmentary system is very great. According to Herbert Hoover, the 2000 miles of separate segments of the Mississippi system carried during a recent year 41,000,000 tons of freight as compared with 45,000,000 tons carried by the unified 7000-mile system of the Southern Railway. "If," he said, "a waterway system of stretches and patches can make such a showing as this, we need summon no special courage to complete it."[4]

There is place here for a word of national warning. Although it is true that the St. Lawrence waterway can not be built except through international coöperation, Canada is under no such limitations when it comes to other outlets to the sea. The Georgian Bay Ship Channel would be strictly her own affair; so would be the completion of the railroad to Port Nelson on Hudson Bay affording for perhaps two or three months of the year an outlet to the sea that would mean a rail journey of only 400 to 500 miles from the wheat area of North Dakota and Manitoba. Such a program is now seriously considered in the Dominion, the railway is gradually being extended and when freight cars may dump their wheat into a ship on Hudson Bay it only depends on the practicability of the sea navigation through the ice barriers of Davis Straits to make this route a preferred one for Canadian grain, destined for northern Europe. Even today Canada is fostering her grain export business through the imperfect St. Lawrence and Welland Canals. The completion of the new Welland will add to the attractiveness of that route in which until the completion of the St. Lawrence channel the United States will not greatly share and with which it can only compete through better coöperation between railroad and shipping interests and through the completion of the Mississippi waterway to the Twin Cities.

And there we come to another prerequisite for the success of an inland waterway system. Construction, like patriotism "is not enough." There must be at the first some government operation and protection until the legal rights of the new carriers are fully established and their trade routes become habitual to shippers, and there must at all times

[4] Address before Missouri River Transportation Conference, Kansas City, Missouri, October 19, 1925.

be coöperation between the waterways and the railroads, a coöperation not merely voluntary but enforced by the expressed edict of the people of the United States. The fact may as well be faced that except in such favorable locations as the Great Lakes and the Ohio, no inland waterway common carrier can compete with the railways for any except local traffic unless there is an agreement between the rail and water carriers by which through rail and water rates are reduced. In other words the railroad must give preference to shipments to be delivered to the waterway for forwarding to their final destination and it must do the same for shipments delivered to it by the waterway for delivery along its own or connecting rail lines. It is safe to say that the unquestioned success of the Inland Waterways Corporation has been due more to this one policy than to any other single factor. It has been able to come to such agreements because of decisions of the Interstate Commerce Commission and because its opponents realized that in fighting it they were fighting the United States, a job a little too big for even a big railroad to undertake. Before the equipment of the Inland Waterways Corporation is sold to private enterprise or before any serious attempt is made to foster common carrier water traffic on the Mississippi system there must be the legal certainty that such a policy of coöperation must prevail. Otherwise the waterways will never be national systems except in so far as on the Great Lakes their commerce builds the foundation for cheap raw materials. They will never be common carriers without coöperation with the railroads; they will merely serve to carry local products along the valley, to the advantage of the valley cities along their banks and perhaps to the real disadvantage of the rest of the country which will pay for a waterway which it can never use and which will also suffer from increased freight rates imposed by the railroads in order to make up for inadequate rates forced by the competing waterway along its course.

Such a policy of coöperation will ultimately benefit the railroads as many of them are already beginning to see. The cheap water transport on the lakes, providing cheap raw materials for the industries along their shores has resulted in a huge volume of high class freight for every railroad in that territory. There would be no such great cities as Pittsburgh, Cleveland, Detroit, and Chicago, if all their coal and all their iron ore had to be hauled by rail. The same is true of the Monongahela and Ohio which have made the Pittsburgh steel district what it is. "Why is it" asked the schoolboy in the story, "that the big rivers flow by the big cities?"

An era of coöperation between rail and water lines by which the water routes would be given the preference for the carriage of low class bulk freight wherever possible would result in such an increase in the industrial prosperity of the territory affected as to provide the rail lines with an even greater amount of high class merchandise. If, through receiving 10 cents a bushel more for his wheat every midland farmer had $100 more to spend every year, how much in the way of high class freight would it mean to the railroads in that territory?

If Commodore Vanderbilt or any other of the great railroad builders of the last century had been told in 1880 that less than fifty years from that date the rivers, canals, and connecting channels of the United States would carry almost exactly three-fourths as much freight as all the railroads of the country were carrying that year, and that if the total for the Great Lakes were added the inland waterway tonnage of 1926 would exceed the rail tonnage of 1880 by 64,000,000, they would very likely have viewed the prospect with needless alarm, for the railroads did manage to worry along and to carry upwards of 2,400,000,000 tons in the latter year. James J. Hill was nearer right, when in 1908 he declared that the railroads had nothing to fear from waterways, that their proper relationship was one of harmony. He then advocated a fourteen-foot channel from Chicago to the Gulf of Mexico and a ship canal from the lakes to the sea by the route of the old Erie Canal, then being reconstructed as the present barge canal, which he termed "a valueless shallow ditch." He also called the St. Lawrence Canals failures but had he lived he would have had in that instance to have revised his judgment for a system which is being worked to capacity, as the St. Lawrence Canals now are, could scarcely be deemed a failure however much their further development might be considered desirable. But in his advocacy of a unified system of inland waterways he was ahead of the railroad opinion of his time as he was when he said, "the future of waterways is assured not so much as a competitor, but as a helper of the railroad."[5]

This relationship has seldom been as clearly expressed as by Professor Emory R. Johnson who wrote in 1909,

"Waterways are complements of the railroads. In the long run water competition is not ruinous, but helpful to the railroads. The truth of this somewhat paradoxical statement is due to the fact that the two means of transportation are different agents of commerce. The waterway, such as the Great Lakes or the Rhine River, by pro-

[5] *Future of Rail and Water Transportation.*

viding facilities for the cheap transportation of a large tonnage of bulky commodities, so promotes industrial development and so increases the density of population as ultimately to give the railroads a larger and more profitable traffic than they would secure if the waterway were not in existence.

"Being complements as well as competitors of the railroads it is desirable both for the public and for the railroads that the two means of transportation should be coördinated. While there is no sharp division of freight between waterways and railroads —one kind of freight being carried invariably by water and the other kinds by rail— the coördination of the two means of transportation enables each carrier to handle the traffic for which it is best adapted. This coördination of rail and water routes has been well worked out on the Great Lakes with most economical results."[6]

The case for government supervision of water-borne commerce in so far as concerns railroad competition rests upon the fact that at the present time railroad opinion is not wholly converted to the points of view expressed in the preceding paragraphs. Demonstrations such as that given by the government-owned Inland Waterways Corporation are needed. Listen to Major-General Thomas Q. Ashburn, general manager of that concern which in five years established water common carriage on the Mississippi on a firmer foundation than it had enjoyed for sixty years:

"I am convinced that no agency, other than the Government of the United States, could have withstood such vicious assaults made upon it, such misrepresentation of facts, such combined attacks to belittle the demonstration of common water carriage, and to prevent its success, as the Government has in the reëstablishment of the great common carrier operated on the Mississippi-Warrior Rivers by the Inland Waterways Corporation.

"Private capital will undoubtedly invest in private and contract carriers and do all it can to justify the creation of navigable streams, but to fully distribute the benefits of such cheap transportation requires upon each river a demonstration by the present fully empowered governmental corporation until such times as the conditions precedent to success are established and private capital will invest in an operation no longer a hazardous venture.

"The sine quo non of successful common water carriage is coöperation with the railroads."[7]

With these words we can sum up the requirements for the development of our inland waterways. First, provide channels and boats and terminals adapted to their use; second, provide railroad coöperation, preferably voluntary, but provide it. Then let the government maintain

[6] *Ocean and Inland Transportation*, page 377.

[7] Address before the Mississippi Valley Association, St. Louis, November 14, 1925; printed in *Congressional Record*, December 19, 1925.

the channels free from natural encroachments and from those desired by competitors in the way of bridges, a device becoming increasingly common by motor and rail competition. If these conditions are met, the future of water transportation is not merely secure but brilliant.

If they are not so developed but left as a neglected resource, what then? It has been seen that in one decade the railroads have increased their capitalization more than $3,900,000,000 and that practically none of it was spent for new mileage but rather in the perfecting and enlargement of existing facilities. Unless the railroads are relieved of a part of this burden by the extension of waterway facilities, this additional expense must go on for decades to come and, as the consumer and the producer both pay the freight, the toll of it must come directly or indirectly from every inhabitant of the country. What the railroads must spend in another decade on improvements would much more than suffice to complete the waterway system that has been outlined, and such a system would help the railroads in the same way the present Great Lakes system helps them, by relieving them of the relatively unprofitable traffic in bulk commodities which in their turn provide the roads with an ultimate traffic in the highest class of profitable freight manufactured from these same bulk materials. Neglect of waterway development means relatively congested railroad transportation, burdened with a largely profitless task and compelled to make both ends meet by higher charges on all classes of freight. It means a slowing up of the wheels of progress, for cheap transportation is the life-sap of nations.

There remains a final word. No individual nor any nation can without penalty fail to develop its peculiar resources and gifts. Nations are also like men in that they differ as to the nature of those gifts. Greece expressed itself in beauty of form in line and word; Rome in law and administration; the Hebrew nation in religion; modern England in world commerce. Here in America we are faced with the problem of transmuting the immortal, even though unfashionable, ideals of equal opportunity for individual development into the terms of a modern industrial and mechanized society. To do this will require the use for all of every material resource at our command. One of the greatest of these is that simple substance known as water; and as to the responsibilities which this resource implies we cannot do better than listen to a closing word from the American who knows most about it. Herbert Hoover has said:

"We have been blessed by Providence with resources in water greater than any nation in the world. Through the advance of engineering science their possibilities have become a reality, not a dream. These resources are so situated that their use will bring rich harvest in wealth and happiness to all our people. The foundations of agriculture and industry can be strengthened and our population better distributed. We have recovered from the devastating losses of the war to a period of economic strength which enables us to undertake them without national burden. We shall be negligent of our duty if we fail in their development."[8]

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[8] Address before Columbia Basin League, Seattle, August 21, 1926.

CHAPTER XVI

Conclusion

The greatest gifts to man are the most universal. He can live scarcely two minutes without air, a few days without water, a few weeks without food; and of all substances, air and water are most widespread in their distribution. The life-giving sun shines alike on the evil and on the good, and it unites with the rain which falls upon the just and upon the unjust, to give bread to all mankind.

America was discovered by men impelled by the winds, sailing across the water to find more abundant bread, for the gold they looked for was sought only as a means to easier living. Steam and motors have supplanted the winds but from the day Columbus hoisted his sails in the harbor of Palos until the present, the history of America has largely and in no sinister sense, been "writ in water" and in the desire for bread. We have seen the first discoverers threading their uncertain ways up the unknown rivers of the New World, we have seen the settlers following the same road westward down the Ohio, up the St. Lawrence and the Mohawk, and across the Lakes. We have seen the land which they cleared and settled dependent for decades upon water as its only cheap form of transportation; its economic life depending upon rain and rivers. Abraham Lincoln was nearly a grown man before people began to use nails and window glass in Indiana and Illinois[1] and these came only with the development of water carriage.

Then came a time when the invention of railroads obscured the dependence of inland America upon waterways. People pushed out from the river valleys, across the prairies, following the thin ribbons of steel and in time building a group of great commonwealths remote from the sea or any great navigable stream. For a time all went well. The communities were relatively self-sufficing. Such manufactured articles as they needed could easily be paid for by the superabundant harvests of their virgin fields. Money and luxuries were scarce but food was plentiful. Population grew, industry crept in and finally about the beginning of the present century we had developed a populous and pros-

[1] *Abraham Lincoln: The Prairie Years.*

perous region from the Alleghenies to the Rockies, living well on the proceeds of the sale of its surplus grain and furnishing a rich home market for its own industries fed by raw material not relatively more costly than on the seaboard.

Then things began to happen. The Panama Canal was opened, and the War came and passed into history. Following the depression in ocean freights ensuing upon the over-building of ships to meet the vanquished U-boats, the competitors of our inland states in Argentina, Australia, India, discovered that they could unload their grain at Liverpool cheaper than could the Illinois or Dakota or Kansas farmer. The reason was not only lower ocean freights for them but higher rail freight charges for their American competitors, whose wheat ripened three to five times as far from the sea as theirs did. The immediate result was that the American farmer in our midland states faced a handicap of from five to twelve cents in the price of his wheat in the markets of the world. Sometimes Argentine growers could even undersell him in United States ports, even in the face of the tariff.

That was one thing that happened. The other was that the Panama Canal began to squeeze the agriculture and industry of the midlands in an economic vise. The people who helped pay for it were not only not benefited, they were penalized. Quoting from an official report we read that,

"If we take as a unit of measurement the cost in cents of carrying a ton of staple goods . . . . taking the cheapest route, we find that before the war New York was 1904 cents from San Francisco while now it is only 1680 cents away. Chicago, which was 2610 cents away from the Pacific Coast before the war, is today 2946 cents away. In other words, Chicago has moved 336 cents away from the Pacific Coast and New York has moved 224 cents closer. A similar calculation will show that in the same period, since ocean rates have remained about the same, Chicago has moved 594 cents away from the markets of the Atlantic seaboard and South America. The same ratios apply to the other mid-west points."[2]

The result of this is two-fold and cumulative. The farmer finds it more difficult to sell in world markets, and the factory owner finds it cheaper to produce his material for foreign trade on the coasts leaving only enough production capacity inland to satisfy inland demand. Lowered industrial production means diminishing local markets for the farmers and a reduction in their earning power means still less

[2] St. Lawrence Waterway Project (*Hoover Report*), Senate Document 183, Second Session, 69th Congress, page 2.

returns for the factory. It is a typical example of a vicious circle. Meanwhile both coasts prosper, the Atlantic receiving the cheap foodstuffs and lumber of the Pacific, the Pacific the manufactured articles of the Atlantic, all carried by cheap sea transportation. The inland region, especially in the north, tends to lose ground, to fail to get its share of national prosperity. The only remedy is cheaper transportation.

Material reduction in railroad freights seems unlikely. If it came as a result of a general industrial depression, such a depression would probably be world-wide and would result in lower ocean freights which would keep the balance just about where it now is. Lower freight rates can hardly come about except through lower wages and cheaper materials. If these are cut enough to make a rate cut possible it will mean a general slump in business everywhere. Nothing except vastly improved railway technic can lessen the inequality between rail and water freight charges. Such an improvement has occurred in the past, but it is approaching the limit of its effectiveness. Locomotives can not be built much larger nor more powerful than they now are nor the capacity of freight cars much increased without tremendously expensive alterations along the permanent way of every railroad. Even were that done, the unescapable physical fact would remain that it takes less energy to move freight through the water than upon rails. Improvements in ocean carriage are keeping pace with those on land.

Short of some undreamed of and revolutionary discovery akin to that of the steam engine, the only way to put the midlands on something like an economic parity with the sea coast is through waterway development. What sort of development is needed we have seen and how much it will cost we know, a cost not excessive when compared with the estimated spending of a billion dollars a year upon our improved highways. What conditions must be met to make such development effectual are also known. There is no magic about waterways. No sane advocate of them wants a canal across the Rocky Mountains nor thinks it would pay, but there are schemes whose success is as certain and assured as that of any transportation project, more certain than some which have played a great part in our national history, such as the early Pacific railroads. All of these received heavy government subsidies of one sort or another, nearly all went bankrupt, yet nearly all today are in a state of high prosperity and are now as they always have been, mighty factors in our national life.

The urge toward the sea is one of the deepest motives in human

history. Based perhaps upon some deep, hidden biological memory, certainly upon economic necessity, it has moved peoples and made history since history began. Our inland states feel that urge today and know that it is for their life. It is the task of our engineers, our lawmakers, our transportation experts to work out a consistant plan of national scope and it is the task of us all to understand and to support it. Such a vision has been a part of American statesmanship from the very first and was by no one more clearly seen than by our first President with whose words of insight and wisdom this book may properly end.

Less than a year after his retirement from command of the army, Washington left Mount Vernon in 1784 on a two-month trip to the Ohio Valley where he owned large tracts of land. He recorded in his diary his opinions of the transportation needs of this virgin country; set down routes and distances to the seaboard from the present sites of Detroit and Pittsburgh and uttered these significant words which might be addressed today to short-sighted dwellers along the coast:

"Let us open a good communication with the settlements west of us—extend the inland navigation as far as it can be done with convenience—and show them by this means how easy it is to bring the produce of their lands to our markets, and see how astonishingly our exports will be increased."[3]

Nothing more need be added to that.

[3] *Washington and the West*, page 99.

SOURCES

There are few general works on American waterways and fewer still of recent date. Facts in abundance may be extracted from a multitude of official reports and documents, but there is little in the way of interpretation of them. Much of such interpretation is colored with prejudice of one sort or another. Herbert Quick's *American Inland Waterways*, published in 1909, is a readable piece of waterway propaganda; but it is a book written with enthusiasm rather than judgment and the modern student of waterways will find in it little of present value. On the other hand, Moulton's *Waterways versus Railways* is a thorough-going piece of anti-waterway propaganda. It is however more complete on the economic side than Quick's book; it shows the weakness of some arguments for waterway expansion, and however much one may differ from its conclusions it deserves study. *Our Harbors and Inland Waterways* by Collins is merely a Sunday newspaper feature article expanded to the length of a book. It is good descriptive stuff but makes no pretence at anything more.

Many more titles than those presently to be enumerated are to be found in any thorough bibliography of waterways. Those referred to here are nearly all those which were actually used in the writing of this book as were others not enumerated, these however being of the nature of reference works such as year-books and encyclopedias. For example, many other histories might be referred to which contain matter bearing on the early history of our rivers. Those given have been thought sufficient as this book makes no pretence at being a comprehensive history.

Subsequent to the period of discovery, a few books stand out as being of unusual value in tracing the development of our waterways until the close of the old-fashioned steamboat and canal era. The whole field is most interestingly covered in the four volumes of Dunbar's *History of Travel in America*, while there is nothing better on the canal period than *Old Towpaths* by Harlow. The fascinating story of the development of steam navigation on our inland rivers is well told by Hulbert in his *Ohio River* and by Herbert and Edward Quick in their *Mississippi Steamboatin'*: while *The Mississippi River* by Chambers is a delightfully readable combination of history and description.

All these books however belong chiefly to a period that has passed away. For the present time and its problems we must turn usually to official reports. First among these are the annual reports of the Chief of Engineers of the United States Army which give a thorough and accurate picture of the volume and course of traffic and of the present state of every navigated waterway. Close to them in importance are the many special reports of examinations and surveys by the Corps of Engineers which give the fairest picture of conditions to be had anywhere. For a general statement of conditions on our waterways, *Inland Waterway Transportation in the United States* by the Department of Commerce will be found preëminently useful, while the report of the National Waterways Commission of 1912 although out of date still contains much of value.

For the Great Lakes and their possible connection with the sea, the best authorities are *Transportation on the Great Lakes*, a voluminous, lucid study of lake commerce by the Corps of Engineers; the report of the International Joint Commission on the St. Lawrence Navigation which is a rich mine of data of all sorts for the whole lake system; and the report of Herbert Hoover, chairman of the United States St. Lawrence Commission, in 1927, which gives the best account of the engineering problems. Other valuable sources are *Great Lakes to Ocean Waterways* by the Department of Commerce and the *Transportation Economics of the Great Lakes-St. Lawrence Ship Channel* by Alfred H. Ritter, both of which give thorough studies of traffic, actual and probable, of steamship operation costs, of navigation problems and in general of all the factors likely to affect the enterprise. Much of this sort of material is also to be found in the report of the International Joint Commission, before referred to.

The controversial subject of diversions of water from the Great Lakes, especially the famous diversion at Chicago, is best summarized in the report of Charles E. Hughes in 1927 to the United States Supreme Court as Special Master to take testimony in the several cases then before the court involving the Chicago diversion. The whole subject for the entire system of the lakes and of the Niagara River is best covered by the voluminous report of Colonel J. G. Warren, Corps of Engineers, United States Army, referred to as the "Warren Report," and is briefly but clearly referred to in the "Hoover Report" of 1927 on the St. Lawrence waterway project.

There is no comprehensive work on all phases of the Mississippi System. For a physical description the best is *Floods of the Mississippi*, published by the Weather Bureau. The Ohio River is accurately described in the report of the Corps of Engineers and a study of the commerce along that stream and its tributaries has just been issued by the same corps. Major General Jadwin's report on Flood Control of the Mississippi is so far the last word on that subject. The results of the application of modern methods to river commerce may best be found in the annual reports of the Inland Waterways Corporation and in addresses by Major-General T. Q. Ashburn, chairman and executive of that enterprise.

Atlantic Intracoastal Canals by the Department of Commerce is useful but rather out of date and for the best information on the waterways along the Atlantic, Gulf, and Pacific coasts one must consult the reports of the Corps of Engineers on various local sections of the Atlantic coastal project or on the separate river systems of the west coast. The same is true of the smaller tributaries of the Mississippi and the Ohio. In this connection it may be noted that practically all the reports of the Corps of Engineers which are cited are credited to the Chief of the Corps. This is for the sake of brevity and is done with full realization of the fact that the major part of all these reports has been the result of the work of the men in the field, or in the district offices.

NOTE A

The report on canal traffic for the year 1928 shows the greatest increase in volume and the greatest total volume since the construction of the Barge Canal. The tonnage for all divisions of the canal system, exclusive of purely terminal traffic, amounted to 3,089,998, an increase over the previous year of 19.61 per cent. The increase on the Erie, or main line, was more than 23 per cent. The increase was chiefly in the following commodities: wheat, of which one million tons were carried, iron, petroleum, sugar, fertilizers, pulpwood and sulphur.

REFERENCES

Abbreviations: B. E. R. H., Board of Engineers for Rivers and Harbors; C. R. H., Committee on Rivers and Harbors; Chi. San. Dist., Chicago Sanitary District; C. E., Corps of Engineers; Ch. E., Chief of Engineers; H. R., House of Representatives; H. D., House of Representatives Document; S. D., Senate Document.

HISTORICAL AND GENERAL

Abraham Lincoln, The Prairie Years. Carl Sandburg. 1927.

American Inland Waterways. Herbert Quick. Putnam's, 1909.

Artificial Waterways of the World. A. Barton Hepburn. Macmillan, 1909.

Chief of Engineers, U. S. A. Report, 1927.

Commercial Statistics of United States Waterborne Commerce for 1925. [B. E. R. H., C. E.]

Conspiracy of Pontiac. Francis Parkman.

Decline of Water Transportation on Western Rivers. Col. C. McD. Townsend, C. E. Professional Memoirs, C. E., 1910.

Discovery of America. John Fiske. Houghton Mifflin.

Economic History of the Anthracite-Tidewater Canals. Chester L. Jones. University of Pennsylvania, Philadelphia, 1908.

Future of Rail and Water Transportation. James J. Hill, letter of, read at meeting of Lakes to Gulf Deep Waterways Association, at Chicago, October 7, 1908.

Great Lakes, The. Jas. O. Curwood. Putnam's, 1909.

Great Lakes, History of. J. B. Mansfield. J. H. Beers, Chicago, 1899.

History of Travel in America. Seymour Dunbar. Bobbs, Merrill Co., 1915.

Inland Waterway Systems. Statement by Hon. Herbert Hoover, Secretary of Commerce, before C. R. H., H. R., January 30, 1926.

Inland Water Transportation in the United States. Department of Commerce, 1923.

International Waterways Commission, Final Report, 1905–1913.

Jesuit Relations. Edited by Edna Kenton and R. G. Thwaites. A. and C. Boni, New York, 1925.

Mississippi Steamboatin'. Herbert and Edward Quick. Henry Holt & Co., 1926.

Modern Railway and Steamship Lines. W. J. Jackman. Minneapolis, 1912.

National Waterways Commission, Final Report, 1912.

New Discovery of a Vast Country in America. Father Louis Hennepin. Edited by R. G. Thwaites. A. C. McClurg, Chicago, 1903.

Ocean and Inland Water Transportation. E. R. Johnson. D. Appleton & Co., 1909.

Old Towpaths. Alvin F. Harlow. D. Appleton & Co., 1926.

Our Harbors and Inland Waterways. Francis A. Collins. Century Co., 1924.

Railway Statistics of the United States of America for 1925. Bur. Ry. News and Stats., Chicago.

Rainfall and Water Supply. Henry Wayland Hill. New York, 1920.

Tables of Distances. United States Hydrographic Office, Publication 117.

Spanish Explorers in Southern United States. Scribners, 1907.
Transportation by Water. United States Bureau of Census, 1906.
Transportation by Water. United States Bureau of Census, 1916.
Transportation by Water in United States. Report by United States Commissioner of Corporations, 1909.
Transportation on the Great Lakes. C. E., and United States Shipping Board, 1926.
Type of Boat for Inland Water Navigation. Statement by C. Lee Cook before C. R. H., H. R., February 27, 1920.
United States Supreme Court; Report of Special Master, Charles E. Hughes, to the October Term, 1927, re Chicago Water Diversion Cases.
Washington's Journal, 1753–1754.
Washington and the West. A. B. Hulbert. Century Co., 1907.
Water Terminal and Transfer Facilities. Report by C. E., 1913.
Water Terminal and Transfer Facilities. Report by C. E., 1921.
Waterways of the United States. A. H. Weber. 1910.
Waterways vs. Railways. H. G. Moulton. Houghton Mifflin, 1924.
Waterways and Water Transport. J. S. Jeans. 1890.
Waterways, Addresses by Herbert Hoover on. Delivered at Kansas City, Missouri, October 19, 1925; Chicago, March 9, 1926; and Seattle, August 21, 1926.

GREAT LAKES AND CONNECTIONS

Bowen Ship Canals. Personal Statement of Millard F. Bowen on propaganda leaflet.
Canada, Canals of. Department of Railways and Canals, Ottawa, 1923.
Canal Connecting Lake Erie and Ohio River. Report by Ch. E., 1922, H. D. 188, 67th Congress, Second Session.
Drainage and Sewage Conditions in Chicago. Memorandum by Board of Trustees, Chi. San. Dist., 1923.
Department of Public Works, State of New York. Report of Superintendant for 1926.
Diversion of Water from Great Lakes and Niagara River. Report by Col. J. G. Warren, C. E., H. D., 1694, 67th Congress, First Session (Warren Report).
Engineering Board of Review, Chi. San. Dist., Report on Lake Lowering Controversy, 1925.
Great Lakes-Ocean Waterways. E. S. Gregg and A. L. Cricher. United States Department of Commerce, 1927.
Great Lakes-St. Lawrence Ship Channel, Transportation Economics of. A. H. Ritter. Great Lakes-St. Lawrence Tidewater Association, 1925.
Great Lakes Issue, The. Pamphlet by William George Bruce, President of Great Lakes Harbors Association, 1926.
International Joint Commission, Rules of Procedure. Washington, 1912.
Joint New England Committee on St. Lawrence Project, Report of. Great Lakes-St. Lawrence Tidewater Association, 1927.
Lake Erie-Lake Michigan Waterway, Report by Ch. E., 1917, H. D. 343, 65th Congress, First Session.
Lake Erie, Regulation of. Report by Ch. E., 1911, H. D. 779, 61st Congress, Second Session.

New York State Barge Canal, History of. Noble E. Whitford. 1922.
New York State Barge Canal, Transportation Costs on. Bureau of Railway Economics, Washington, 1925.
Precipitation in the Drainage Area of the Great Lakes, 1875–1924. P. C. Day. Monthly Weather Review, March, 1926. Weather Bureau, United States Department of Agriculture.
St. Lawrence Ship Canal Project, Report by New York State Commission, 1921.
St. Lawrence Waterway Project. Report by Hon. Herbert Hoover, Secretary of Commerce and Chairman of United States St. Lawrence Commission, 1927. S. D. 183, 69th Congress, Second Session (Hoover Report).
St. Lawrence Navigation and Power Investigation. Report by International Joint Commission, 1922.
Waterway, Great Lakes to Gulf of Mexico. George F. Barrett. Chi. San Dist., 1926.
Waterway, Great Lakes to Hudson River. Report by Ch. E., 1926, H. D. 288, 69th Congress, First Session.
Waterway, Great Lakes to Hudson River. Report by Ch. E., Supplemental Report, 1926. Document 7, H. R. C. R. H., 69th Congress, Second Session.
Welland Ship Canal. Department of Railways and Canals, Ottawa, 1920.

MISSISSIPPI SYSTEM

Ashburn, Maj-Gen. Thos. Q., Address at St. Louis, Mo., November 24, 1925. Reported in Congressional Record, December 19, 1925.
Elements of Flood Control. Col. C. McD. Townsend. H. D. 51, 63rd Congress, First Session.
Illinois Deep Waterway Commission, Report of 1922.
Illinois and Mississippi Rivers from Lockport, Ill., to Cairo, Ill. Reports by B. E. R. H., 1921 and 1922. Document 2, H. R. C., R. H., 67th Congress, First Session, and Document 7, Same Committee, Second Session.
Inland Waterways Corporation. Annual Reports, 1925 and 1926.
Lakes to the Gulf Deep Waterway. Wm. Arthur Shelton. University of Chicago Press, 1912.
Mississippi River, The. Julius Chambers. Putnam's, 1910.
Mississippi River Commission, Report of, 1926.
Mississippi River, Report and Survey of, by C. E. H. D. 50, 61st Congress, First Session.
Mississippi River, Floods of. United States Weather Bureau, 1897.
Mississippi, A New. T. W. Brown. 1917.
Missouri River, Kansas City to Mouth. Report by Ch. E., 1915, H. D. 463, 64th Congress, First Session.
Missouri River, Kansas City to Pierre, So. Dak. Report by Ch. E., 1926, H. D. 594, 69th Congress, Second Session.
Nine-Foot Channel, Great Lakes to Gulf of Mexico. Report by Senate Committee, February 4 1925.
Ohio River, The. A B. Hulbert. Putnam's, 1907.
Ohio River, The. United States C. E., 1922.

Ohio and Mississippi Flood of 1912. H. C. Frankenfield. United States Weather Bureau.

Old Times on the Upper Mississippi. George Byron Merrick. Arthur H. Clark Co., Cleveland, Ohio, 1909.

Plan for Flood Control of the Mississippi River. Submitted by Major-General Edgar Jadwin, Ch. E., United States Army, December, 1927.

Transportation on Inland Waterways. Brigadier-General Thos. Q. Ashburn. Paper read before Society of Naval Architects at New York, November, 1925.

Waterway, Lake Superior to Mississippi River. Report by Ch. E., 1916, H. D. 1008, 64th Congress, First Session.

ATLANTIC AND GULF COASTS

Atlantic Intracoastal Canals. G. M. Jones and O. C. Moles. United States Department of Commerce, 1918.

Atlantic Intracoastal Waterway. Atlantic Deeper Waterways Association, Philadelphia, 1914.

Cape Cod Canal. Report by Secretary of War, 1919. H. D. 1768, 65th Congress, Third Session.

Cape Cod Canal. Published by Boston, Cape Cod and New York Canal Co., 1925.

Chesapeake and Delaware Canal. Manufacturers Record, July 22, 1926.

Intracoastal Waterway:

- Beaufort, N. C., to Key West, Fla. Report by Ch. E., 1913, H. D. 229, 63rd Congress, First Session.
- Beaufort to the Cape Fear River. Report by Ch. E., 1926, H. D. 450, 69th Congress, First Session.
- Boston to Beaufort. Report by Ch. E., 1912, H. D. 391, 62nd Congress, Second Session.
- Florida, Survey and Reports on Section Across. Ch. E., 1924, S. D. 179; 68th Congress, Second Session.
- Inland Waterway, New York Bay to Gulf of Mexico. Report by Ch. E., 1916.
- Jacksonville to Miami, Fla. Report by Ch. E., 1926, H. D. 586, 69th Congress, Second Session.
- Mississippi River near New Orleans to Corpus Christi, Tex. Report by Ch. E., H. D. 238, 68th Congress, First Session, 1924.
- New Jersey Intracoastal Waterway. Report by Secretary of War, 1917, S. D. 181, 65th Congress, First Session.
- Norfolk to Beaufort. Report by Ch. E., 1916, H. D. 1136, 64th Congress, First Session.
- St. George Sound, Fla. to the Rio Grande. Report by Ch. E., 1917, S. D. 705, 64th Congress, Second Session.

Inside Route Pilot, New York to Key West. United States Coast and Geodetic Survey, 1922.

PACIFIC COAST

Columbia River, The. William D. Lyman. Putnam's, 1909.
Columbia River, Lower, and Willamette Rivers. Report Ch. E., 1921, H. D. 1009, 66th Congress, Third Session.
Columbia River, from Rickey Rapids to International Boundary. Report Ch. E., 1914, H. D. 1112, 63rd Congress, Second Session.
Columbia, Upper. Report by Federal Power Commission, 1923.
Columbia River, Between Mouth of Willamette River and Vancouver, Washington. Report Ch. E., 1924, H. D. 126, 68th Congress, First Session.
Sacramento and San Joaquin Rivers, Calif. Report Ch. E., 1925, H. D. 123, 69th Congress, First Session.
San Joaquin River and Stockton Channel, Calif. Report Ch. E., 1925, H. D. 554, 68th Congress, Second Session.

INDEX

Albemarle and Chesapeake Canal, 139
All-American Canal (Proposed), 77, 108–112
All-American Canal, distances on, 111
All-American Canal, duration of voyages on, 112
All-American Canal, military value of, 108, 109
All-American Canal, navigation season on, 110
Arkansas River, 37
Ashburn, Major General T. Q., 43, 45, 178
Atlantic Coastwise Traffic, 132, 133
Atlantic Intracoastal Waterway, Beaufort to Jacksonville, 140
Atlantic Intracoastal Canals, cost of, 142
Atlantic Intracoastal Waterway, description, 133, 134
Atlantic Intracoastal Waterway, west of Florida, 141, 142
Atlantic Intracoastal Waterway, cost of, 174

Black River, 38
Bowen Ship Canal, 144, 145
Brule, Stephen, 12
Bulk Carriers, 165, 166

California, Great Valley of, 154
California, navigable rivers, 153, 154
Cape Cod Canal, 23, 134, 135
Carquinez Straits, proposed dam, 157
Chesapeake and Delaware Canal, 136, 137
Chesapeake and Ohio Canal, 27
Chicago, diversion of lake water at, 94
Chicago, diversion of lake water, report on, by Chas. E. Hughes, 97
Chicago, diversion of lake water at, United States Courts, decisions on, 95–99
Chicago Sanitary and Ship Canal, 93
Chicago, typhoid fever rates in, 93, 94
Columbia Rediviva, 15, 16
Columbia River, 159, 160
Columbia River, discovery of, 15–16
Columbus, Christopher, 1
Common Carriers, 165, 166
Contract Carriers, 165, 166

Delaware and Hudson Canal, 27
Delaware and Raritan Canal, 27, 137
DeNarvaez, discovers Mississippi River, 9, 10
Detroit River, 65
Dismal Swamp Canal, 139
Duluth, distance from, to Liverpool via St. Lawrence River, 86

Erie Canal, 2, 124
Erie Canal, construction of, 24
Erie Canal, early rates on, 25
Erie Canal, economic effects of, 25

Farman, Joshua, proposes Erie Canal, 24
Farm Relief, effects of waterway development on, 171
Flat-boats, 18
Florida East Coast Canal, 140
Florida, proposed canal across, 141
Fourteen-Foot Waterway Chicago to the Gulf, proposed, 147
French and Indian War, 14

Georgian Bay Canal, 113, 114
Goethals, Major General G. W., estimate on traffic of proposed canal New Orleans to Brownsville, Texas, 142
Golden Gate, commerce of, 158
Gray, Captain Robert, discovers Columbia River, 15, 16
Griffin, first ship on Great Lakes, 60

Great Lakes
Bulk freighters on, 69, 70
Car ferries on, 70
Coal traffic on, 67
Early traffic on, 29
Depths of, 61
Description of, 58, 59
Early steam traffic on, 61
First European vessel on, 60
Freight tonnage on, 66
Grain traffic on, 68
Levels of, 60, 90, 91
Great Lakes Levels
Compensating works, 100, 101
Damage from lowering of, 103
Effect of Chicago diversion, 97
Effects of rainfall on, 102
Effects of Welland Canal on, 92
Great Lakes, ocean traffic from, 30
Ore-traffic on, 67
Package freight traffic, 70, 71
Passenger traffic, 71
Great Lakes-St. Lawrence Shipway, proposed time, of voyage on, 86
Great Lakes-St. Lawrence Shipway, restricted navigation on, 83

Hoover, Herbert, 76, 115, 158, 170, 175, 179, 180
Houston, Texas; ship canal, 155
Huron Lake, discovery of, 12
Hudson Bay Waterway, 175

Inland and Coastal Waterways, coordinated system of, 173, 174
Inland waterways, economic importance of, 171
Extent, cost, and traffic on, 170
Cost of, 161
Cost of completed system, 174
Total traffic on, 161
Inland Waterways Corporation, 42–45
Illinois-Mississippi Canal, 122
Illinois River, 119, 120

Jadwin, Major General Edgar, plan for Mississippi flood control, 54, 55, 56
James River and Kanawha Canal, 27
Joliet and Marquette, first voyage down Mississippi, 10, 11

Keelboats, 18

LaSalle, 13; builds ship *Griffin*, 29, 60
Lake Erie, freight tonnage on, 65
Lake Erie-Lake Michigan Canal, proposed, 145, 146
Lake Erie-Ohio River Canals, proposed, 150, 151, 152
Lake Erie-Lake Ontario, ship canals, 113
Lake Michigan-Mississippi River, waterway, 117, 118, 120, 121
Lake Michigan-Mississippi River, waterway, economic benefits of, 122
Lake Ontario, freight tonnage on, 65
Lake Ontario-Hudson River Canal, proposed, 106–108
Lake Superior, discovery of, 12, 13
Lake Superior-Mississippi River canals (proposed), 147, 148
Levees on Mississippi River, 50, 51
Lewis and Clark Expedition, 16, 17

Manchester Ship Canal, 83
Middlewest, economic handicaps of, 182
Mississippi Basin, 5; isolation of, 6; extent, 33; run-off from, 47, 48
Mississippi River, coal traffic on, 42
Mississippi River, commerce on, 39–42
Mississippi River, discovery, 10–11
Mississippi River, early steam traffic on, 22
Mississippi Floods:
Causes, 47, 48
Causes of 1927 flood, 48, 49
Control by Army Engineers' plan, 54, 55, 56
Control by cut-offs, 54
Control by reforestation, 52, 53
Control by reservoirs, 51, 52
Mississippi River, lower, description of, 38; regimen of, 49
Mississippi River, upper, description of, 34; regimen of, 49

Mississippi River, volume of flow, of the, 32
Mississippi system of waterways, cost of completion, 174
Missouri River:
  Description, 34
  Early steam traffic on, 22
  Regimen of, 49
Morris Canal, 27

Natchez and *Robert E. Lee*, race between, 21
New Jersey Ship Canal, proposed, 137, 138
New York State Barge Canal, 106, 124–131
  Cost of, 124, 125
  Description, 125, 126
  Disadvantages of, 129, 130
  Shipping on, 126
  Traffic on, 126, 127, 128, 131
Norfolk to Beaufort, traffic on waterway between, 139, 140

Ocean freight steamers, drafts, 81, 82
Ohio canals, 27, 28
Ohio River, description of, 34, 35
  Early ocean shipping on, 20, 21
  Early steam tonnage, 22
  First improvement of, 35
  First steamboat on, 21
  Importance of, 18
  Locks and dams on, 35, 36
  Main tributaries, 36, 37
  Modern commerce on, 37
  Regimen of, 49
Ohio River and tributaries, modern commerce on, 37
Oswego, fort at, 14
Ouachita River, 38

Panama Canal, 81–83
Pennsylvania canals, 26
Portland, Oregon, commerce of, 159
Private carriers, 165

Railways of the United States:
  Capitalization of, 168, 169
  Freight tonnage, 169
  Traffic on, 161
Rainfall, total, east of Rocky Mountains, 32
Rates on old-time river steamboats, 166
Red River, 38

Sacramento River, 154, 155, 156
  Proposed dam, 157
  Proposed reservoir, 158
  Use of for irrigation, 156, 157
St. Clair, brig, first seagoing Ohio River vessel, 20
St. Clair River, 65
St. Francis-Champlain Canal, 112
St. Lawrence Canals, 73, 74; present traffic on, 87
St. Lawrence Commission, United States, 76
St. Lawrence Rapids, 73, 74
St. Lawrence River, canals along, 62
St. Lawrence River, description, 73, 74
St. Lawrence River, freedom of navigation on, 116
St. Lawrence Waterway, proposed, cost of, 77, 87, 174
  Description of, 78, 79, 80
  Economic advantages of, 115
  Estimated traffic on, 84, 85
  Navigability for ocean shipping, 82, 83
  Estimated savings from, on freight charges, 86
San Joaquin River, 155, 156
Sault Ste. Marie, canals at, 62, 63
Scriba, George, Frederick, William, 23
Sixth Great Lake, a proposed, 148, 149
Steamboat era on inland rivers, 21
Stockton, California, ship canal, 155, 156
Suez Canal, 83

Through rates, necessity of, 166
Townsend, Colonel C. McD., 163, 164, 165
Typhoid Fever, rates in large American cities, 94

United States Supreme Court, decisions on Chicago diversion of Lake Michigan water, 96, 99

Wabash and Erie Canal, 28
Washington, George, trip to French outposts in Pennsylvania, 14
Washington, George, trip to Ohio Valley in 1784, 184
Waterways, coöperation of railways, 176, 177, 178
Waterway development, results of neglect of, 179
Waterways, government operation of, 176
Waterways, necessary conditions for success of, 163–166
Welland Canal, 29, 30, 63, 64
Whipple, Commodore Abraham, 20
White River, 38
Willamette River, 159, 160

Yazoo River, 38